TECHNOLOGY

TECHNOLOGY DEPT.

November 1957

# approach

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THE NAVAL AVIATION SAFETY REVIEW

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**See Inside:** SEA SQUATTER SAGA page 4 . . . COMPRESSOR STALLS page 8 . . . COLD FEET page 30 . . . O-RINGS page 36

# Letters

*Approach* welcomes letters from its readers. Send yours either via official channels or direct on Anymouse forms. All letters should be signed. However, names will be withheld on request.
Address: *Approach* Editor, U. S. Naval Aviation Safety Center, NAS Norfolk, Va.

## NIS

Sir:

. . . Concerning the "right seat plane commander" in the July issue . . . and your remarks about 'seeing the flight surgeon'. (page 12): A flight surgeon was not assigned our squadron throughout most of the cruise and we had to use the carrier's. He was tremendously overworked and had no time to get to know the airgroup pilots.

LT USN

*True enough. Flight Surgeons are scarce people and some units don't even have a billet for one. But the point remains—when the situation calls for outside council it's logical to seek whatever service is available.—Ed*

## SIGNIFICANCE

Sir:

. . . Re CNO Aviation Safety Awards Oct. APPROACH: I came across the enclosed clipping from the December 1954 issue of "Railroad Safety Newsletter," which I think does a good job emphasizing the real meaning and value of a safety award . . .

"WHAT GOOD IS A SAFETY CERTIFICATE?" That's a good question, and it deserves a good answer. Some fellows are prone to think it is "just another *piece of paper* to hang on the wall or to get tossed in a drawer."

However, there is a lot behind a safety certificate. For every one that is issued . . . there are a number of men who have escaped serious injuries during the year. It means that the members of a certificate-winning group have cooperated to avoid accidents not only to themselves, but to every other member of the team, and that a lot of men were able to avoid the pains and idleness that go with injuries. It means that the fellows working in one of these teams can feel confident of their safety, and that a lot of families were spared the sorrow and anxiety of being deprived of a loved one.

Oh yes, a safety certificate does mean something, it means so much that it's worth the effort of cooperating with all the rest to earn one.

While the winning of a certificate relates a story of happiness and security, the failure to win one implies the absence of one or more men from their jobs either temporarily or permanently — it implies that someone has done some suffering and that maybe a family is bereaved of a loved one. So don't let anyone tell you that a safety certificate means nothing. Just look at the ones that haven't got one and you'll find a painful story, also the answer to "What good is a safety certificate?"

A READER

*Yessirree!—Anyone disagree? — Ed.*

## HOLD ON

Sir:

A March 1957 Weekly Accident Summary lists an FJ3-M colliding with the water "in excellent landing attitude after catapult launch," with a fatality.

A more fortunate similarity occurred recently on the FDR during carrier qualification. I observed an F9F-8 settling 'in excellent landing attitude after catapult launch' approximately half the way from the flight deck to the water before a sudden climbout. The cause was revealed to me later by the pilot—"the darn stick got away from me during launch, and I had to chase it around the cockpit for several moments before catching it."

W. W. UTHLAUT
LT (MC) USNR
Cherry Point

## PLAY TRUMP

Sir:

What can be done in regards to aircraft incidents which require a FLIGA report when such reports are squelched at squadron level?

. . . Like Grampaw would say "you can't make all the mistakes yourself so learn from the mistakes of others." If the incidents are reported, maybe someone can learn a little and prevent a recurrence of the same things.

BEWILDERED SO

*Suggest you send in such reports as Anymouses, and that they be kept truly anonymous — at least that will fulfill the primary objective of helping to prevent a recurrence. As to the squelching of potential FLIGA reports in your squadron, or at any level—neither the boss' comments nor mine are fit to print! Also as noted in recent correspondence. "It was the intent of the Bureau to reject this ECP, but in the light of the statistics presented to them by the Naval Aviation Safety Center they intend to re-evaluate the program."*

### CORN JUICE

Sir:

Have you seen the 5 July 1957 issue of Medical News Letter? It contains a valuable sequel to your "Case of LCdr. Joe Ziltz" (Sept 1956 Approach) on the subject of alcohol. In it Dr. C. W. Muehlberger, director of the Michigan Crime Detection Lab, shows graphically how a person like Ziltz can feel "really bombed" after taking on a specified amount of corn juice, but later, when his blood alcohol has soared beyond that point and has begun to coast (slowly) downhill, he *feels* a whole heap better *even though his blood alcohol is only back to the same level* where it was when the pink elephants were around! In other words, he's feeling better because in the recent past he was much worse —same as the good feeling you get when you stop beating your head against a wall. Important thing is that his performance at both points is almost equally poor, but if Ziltz doesn't know this he's heading for trouble. Recommend you pass this along to all readers, for the benefit of those whom the shoe fits.

FLIGHT SURGEONMOUSE

*Thanks, Doc. Aviators desiring copies of Ziltz's planning chart, showing how long it takes to get rid of how much on a by type drink basis, will have to resort to the gray market.* APPROACH *files of that issue are exhausted. A chart reprint might be considered if sufficient requests are received.*

### BIEN HECHO

Sir:

Re July APPROACH back cover . . . Spanish translation has quite a few mistakes . . . there are several other ways to say the same thing and in a proper manner.

However, I say again WELL DONE to Clifford E. Overton. Also I have turned to be a *Coffee drinker* since I saw that picture on the back cover.

AGUSTIN DE LA GARZA
USS Kearsarge, (CVA-33)

*NATO interpreters did the translating and all concerned had varying opinions regarding certain words and phrases also.—Ed*

Continued next page

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# approach

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This periodical contains the most accurate information currently available on the subject of aviation accident prevention. Contents should not be construed as regulations, orders or directives unless so stated. Material extracted from Aircraft Accident Reports, (OpNav 3750-1), Aircraft FLIGA Report (3750-10), and Anymouse (anonymous) Reports may not be construed as incriminating under Art. 31, UCMJ. Names used in accident stories are fictitious unless stated otherwise. Photo credit: Official Navy or as credited. Articles may be reprinted with prior permission.

Contributions are welcome as are comments and criticisms. Address correspondence to Director, U. S. Naval Aviation Safety Center, NAS Norfolk 11, Va.



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# Letters
Continued

## FALSE ARREST

Sir:

IN RESPONSE to your request (APPROACH, p. 40 December) for information on the value of utilizing field arresting gear to minimize damage to nose assemblies of tricycle gear aircraft in cases where the nose-gear will not extend, I submit the following report of one incident involving TF-1 aircraft.

We have experienced four instances in which the nose-gear has failed to function properly, with one incident terminating with engagement of field arresting gear.

In this instance the aircraft was returning from a COD flight and the malfunction of the nose-gear was encountered after takeoff from the carrier. Carrier takeoffs were involved in all instances of nose-gear malfunctions.

Upon retraction of the gear after takeoff the nose-gear cocked approximately 45° and jammed upon entering the well, thus leaving the doors partially open and the gear partially out of the well. Reaching the home field, attempts were made to lower the gear by the normal system. The doors opened but the nose-gear remained jammed and would not extend. Use of the emergency system failed to break the gear loose. Two unsuccessful attempts were made with a hard bounce on the main mounts in an effort to jar the gear loose.

Then a normal approach was made to engage the arresting gear. Both engines were feathered as the aircraft crossed the field boundry. Engagement was made at approximately 80 knots. Both propellers went to the full feather position but continued to windmill slowly until striking the runway. The aircraft skidded to a stop on its nose after a runout of 525 feet. Upon engagement of the arresting gear the nose immediately dipped and struck the runway and the entire runout was on the nose.

Damage to the aircraft required replacing the nosewheel doors, both propellers, and flooring in the cockpit, which had been torn out in an attempt to free the jammed gear (*ASC 242 as noted in June 1957* APPROACH *requires marking of deck*). Feathering the propellers prior to touchdown prevented any engine damage. No personnel injuries were involved.

Discussion of this incident with the pilots involved and other pilots in the squadron has led us to favor a procedure of not using the arresting gear in such cases. It is felt that holding the nose off and making a normal rollout without braking will allow more time for the propellers to stop completely and possibly time to position them with the starter, thus eliminating the damage to the propellers. Also, we have found that the nosewheel can be kept off the deck until a speed of approximately 40 to 45 knots is attained. This condition is attainable with a two-thirds flap setting. With full flaps the nose falls through at a higher speed.

It is also felt that with the center of gravity of the TF being affected greatly by small changes, it would be possible to move passengers or cargo aft in the cabin allowing the aircraft to come to rest on its tail without any damage to the nose. (See Letters to the Editor APPROACH, Dec. 1956.) This action was not possible in the above case because the aircraft was empty with only the pilot, copilot and plane captain aboard.

We do not think it possible to engage the arresting gear and hold the nose off by the use of weight in the aft of the cabin, nor would it be safe to move passengers aft during an engagement.

We understand that constant runout arresting gear is available on short notice at NATC, Patuxent River. However, it is felt that use of this gear would also cause a nose-down situation after engagement, possibly at a lower speed, but we feel that more damage would result from use of the arresting gear than from a normal rollout.

G. W. COBB
VR-22

*Reports of similar experiences are welcomed.—Ed.*

## NEPTUNE KNACK

Sir:

As an ex-P2V pilot and one time commanding officer of a squadron fortunate enough to earn the CNO Safety Award, I would like to take issue with several statements made in the article "Landing the P2V." I believe that a literal interpretation by an inexperienced pilot could easily lead to trouble.

The paragraph on traffic pattern and approach says "During flare out, apply nose up varicam and continue the power reduction. Approximately 4 to 6 degrees of varicam will produce a smooth landing." Certainly this much varicam will produce a smooth landing, but so will a landing with 1 or 2 degrees or even zero, pilot may get the idea that 4 to 6 degrees should be used regularly, when actually it is generally too much varicam for normal landings and one almost certain to get you into trouble if a wave-off followed by a "flaps-up" ensues. Two-to-one you'll get such a nose up condition with 6 degrees that it will take two men and a small boy to hold it. I believe you'll find that the consensus of most pilots will call for a power-on landing with 1½-2 degrees of varicam for most normal landings. The author points out the danger of the varicam pitch-up elsewhere in the article, but I feel it best not to get into a position of potential embarrassment if you can avoid it—and the best way to guard against trim problems on an unexpected wave off is to take it easy on the varicam. A P2V will touch down like a feather carrying 15" to 18" and 2 degrees or less of varicam.

My second point of contention is in Mr. Beasley's advice on a single-engine roll out; "Allow the nosewheel to contact the runway and use reverse pitch on the operating engine." For my money the best bet is to lay off the reverse pitch unless you are definitely running out of runway. Many a landing has been botched by the improper use of reverse pitch. A well executed single engine landing still gets no bouquets if the aircraft ends up in the boondocks because it swerved off the runway on a roll out. Brakes alone will generally do the job on most of the runways we operate from today. Reverse pitch, single engine, should be reserved for those times where it can mean the difference between stopping or not.

Except for the above differences of opinion, I think Jay Beasley rates a Well Done for a detailed and illuminating article.

W. G. MATTON, JR.
CDR, USN

*Everyone seems to have some individual preferences — meanwhile, the P2V landing accident problems continue! Any other comments?— Ed.*

## TED PROJECT

Sir:

This letter proposes a modification to aircraft equipped with IFF which will automatically turn on the emergency IFF whenever the pilot ejects or attempts to eject.

Current doctrine in most operating units is to turn on emergency IFF prior to bailout or in any other emergency where assistance is required.

In the majority of bailout situations, excluding such occasions as fuel exhaustion, the decision to eject is followed immediately by leaving the airplane. The pilot may have time to turn on his emergency IFF but more usually thinks of this some hours later.

Because a large percentage of the continent and most of the area where carrier-based aircraft are operating is constantly under surveillance by GCI radar, it appears desirable to provide a means whereby anyone bailing out will have his emergency IFF turned on automatically. In this way the position where bailout occurred and the time of bailout will be known immediately. The aircraft can then be tracked to the approximate point of impact and Search and Rescue will know approximately where to find the pilot, depending upon such variables as wind, and time of free fall. This information is obviously more useful than the usual situation where an aircraft simply fails to arrive and could be anywhere in several thousand square miles of area.

It is recommended BuAer investigate:

a. The feasibility of installing circuitry in IFF-equipped aircraft in such a manner that the emergency IFF will be turned on when the canopy is jettisoned, when the seat is fired through the canopy, or both.

b. If feasible, determine Air Force interest in equipping aircraft with this type of installation and the reaction of Air Force commands concerned with operation of Surveillance Radar, SAR, and Flight Safety. In addition, consideration should be given to wiring the standby circuitry of the IFF equipment through the landing gear nutcracker switch in order that the IFF will be on standby whenever the aircraft is in flight. This is to make the *emergency* provisions function properly should the pilot fail to turn the IFF on after takeoff.

W. J. MORAN, CDR
China Lake

*TED project directive ADC-EL-43042 was established at NADC, Johnsville, Pa. to investigate the feasibility of the proposed modification. A favorable report on such mods is now awaiting disposition in Washington.—Ed.*

## LIVE 'N LEARN

Sir:

It all started in the chocks when I was back seat pilot in a TV-2. Weather was VFR and expected to remain so on both occasions mentioned here. The pilot up front was a senior officer with many hours but only a few in jets.

As usual, I was double-checking the pilot with my own checkoff list. Everything seemed o.k. except the trim. The pilot was busy, so I ran the elevator and aileron trim to the takeoff positions. I looked up to see the pilot talking to the plane captain and overheard him ask what the tiptank transfer warning light was doing ON.

I explained over the intercom that, once the switch had been turned ON the light would remain ON until approximately 5 psi had been built up in the fuel lines. I then suggested that the tiptank transfer switch be left OFF until taking the active so that the fuselage tank fuel could be used down to allow a check of the leading edge and wing group transfer prior to takeoff.

He replied that his fuselage fuel gage was not working, since it had not dropped after the aircraft was started. I explained that even though sufficient pressure had not been built up in the tiptanks to cause the warning light to go OUT, there was still enough fuel being transferred at idle to keep the fuselage tank full.

After the fuel system was squared away, he called to ask how to trim the aircraft for takeoff. I glanced at the elevator trim light and noticed that it was no longer green. I explained the procedure as I returned it to the takeoff position. A check on the aileron trim showed it had not been moved from NEUTRAL.

A short time later, I flew with the same pilot. He apparently was more prepared this time and everything looked fine except the G-2 compass. After takeoff, I mentioned to the pilot that my G-2 compass had not moved since leaving the chocks and asked him to please check the circuit breakers and fuses. He replied that his was working fine and that nothing seemed out of order. I was given control of the aircraft to fly simulated instruments. Later in the hop, the pilot admitted his G-2 was out and that he had mistaken his radio compass for the G-2. He then asked what I was using for directional control and when I replied "the stand-by compass," he said he did not have one in the front. I pointed it out behind the mirror on the right side of the front of the canopy.

An explanation of taking and giving control of the ARC-27 and ARN-6 was made after several questions concerning their use had been asked of me. To this he replied, "Well, live and learn."

Maybe this pilot was willing to learn, but certainly the time to have done it was on the deck, prior to checking out in the aircraft. Apparently, because this pilot was a senior officer with much flight experience, he was permitted to fly without a proper checkout.

I have the highest respect for the "old timers" who have managed to hang around and help us "youngguns," but with an approach to flying that is almost indifferent, leadership can hardly be that which is desired and expected of the professional aviator.

"YOUNGUN"

*Most oldtimers we know, who fly jets, fly 'em well. Those that don't fly 'em well are doing more than setting a poor example!—Ed.*

# SAGA OF A SEA SQUATTER

"EVERYTHING worked real fine except this lighter I've been carrying for years." the wet but unhurt pilot was telling the skipper of the sub. "Soon as I get into these dry clothes I'll tell you 'bout it."

"Sure, take your time, we've got several hours yet. I'm glad to see all 10 of you got out in good shape—you must have had your crew well trained and ready."

"I'd say we were all pretty lucky too, getting out with just two of us getting slight bruises. Sure glad you people came along when you did though—I was really beginning to cuss this lighter, 20 good, dry weeds and nothing to light 'em with. Gimme a light, would you skipper?"

"Sure, here—you should get yourself one of these, we all use them cause they work *under water*—heh! Now, tell me how this iron bird of yours came to rest in our ocean."

"It came upon us without much warning—we were tooling along with 160 BMEP, 34 inches and 1950 turns when suddenly the starboard recip backfired real violent-like. We riched up the mixtures and reduced MP some, and watched 'er pretty closely. The BMEP was 10 pounds low and fluctuating. Well, we were in the midst of a small conference on the subject when she went POW! again. Kinda muffled this time, and immediately started to burn."

"Fire in the air, that's a real hair-raiser for you guys isn't it?"

"Well, it sure isn't any tea party, but it's an emergency which normally should give you enough time to think and act—if you think and act quickly. The fire generally takes a certain amount of time before it can burn through vital structural members. During that time the plane is, most always, controllable. In our case, for example, we had about 2000 feet so we tried to dive the fire out. Soon as we saw we couldn't, I decided to ditch. By that time we were shedding wheelwell doors and the oil coolers off the starboard engine."

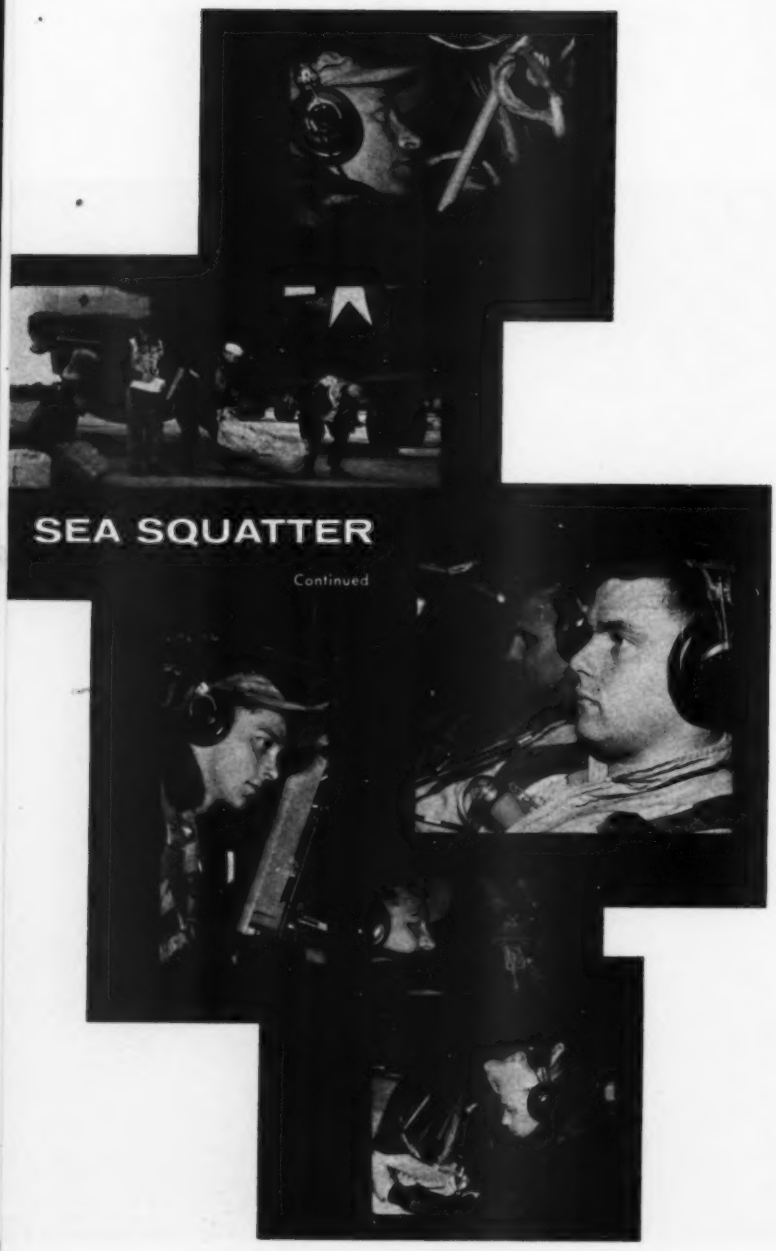
"Did you have much time to prepare?"

"We had about 10 minutes between the first backfire and the time we actually joined the surface Navy. Soon as No. 2 caught fire I shut it down, the copilot secured the gas, oil and hydraulic fluid, and started the jets. We switched to emergency IFF and I had the radioman send an SOS. Right after that we lost all radio and ICS too."

"Do you have an alarm bell or something like our horns to signal for ditching?"

"No we don't, and by gosh that's one thing I'm gonna recommend back on the beach. We shouted the word back to the flight deck, and everyone got

Scene: aboard a submarine shortly after it had picked up the crew of a P2V which had ditched about four hours earlier. The P2V, with a crew of 10, had been on a routine night antisub searchlight exercise and had been airborne about seven hours when it experienced an uncontrollable fire in the starboard reciprocating engine. The pilot had a little over 2000 total hours, of which 1250 were in P2V.




ready in time. The men heaved all loose gear down into the tunnel. Boy, it's important to get that stuff out of the way—I hate to look back at the nav table and see a pair of dividers lying there, pointing right ahead. Anyway, everyone was in his ditching station before we splashed. Radioman popped his hatch open and strapped in facing aft.

**ONE OF THE BOYS** decided the Mk IV raft on the wing center section should be made ready, so he propped it in the radio compartment. I think that's probably why we lost the raft, it must have been washed aft by the inrush of water. They should have left it in place, it's secured for ditching there and can still be jerked loose in a hurry."

"So that's why you were all in one raft—you were crowded in there like a Sheepshead Bay fishing boat. You didn't step right into the raft did you? Like those people did when that commercial plane went in out here recently?"

"No, we weren't quite that stylish. We went into the water and had two men climb in on opposite sides to keep it from tipping. You know, we're all eligible for membership in the Sea Squatters Club."

"Mmmmm, I've heard of that. Some outfit that makes raft inflation gear started it, didn't they?"

"Yep, I know several guys who belong. They send you a lapel emblem and a card that other Sea Squatters can autograph. Sorta like the Short Snorters only more exclusive. I heard of one guy who became a member when he overshot the *Wolverine* in Lake Michigan—as they were trying to haul him aboard he was still trying to inflate his raft to become eligible!"

"With this fairly calm sea I'd guess you didn't have time to travel very far, did you?

"Did you use all of the equipment they put on those things?"

"We didn't try to go anywhere except to pull away from the plane before it sank. It stayed up for about 20 minutes, I guess that's because it didn't break up. Well anyway, we used everything except the emergency rations, and by gosh, like I said, everything worked except this stinkin' lighter. Got another light? Mpfff, thanks. We broke out the radar reflector right away, and the oars. Got kinda worried when my first seagoing command began to ship water and no bailing bucket or sponge in sight. One of the boys contributed his Wellington boots for bailing buckets.

"We cranked up the Gibson Girl, and inflated the balloon with the hydrogen generator. Kinda hard holding that generator under water, I wish they'd weight it more.

"Someone had brought along a flashlight, so we were able to read the instructions. All our life jackets lights worked too, I had everyone turn 'em on when you got near. About two hours after we began sailing we saw a plane coming right for us and we lit off two flares. I guess he saw us right away, cause he began circling, so we quit cranking the Gibson Girl and began combing our hair so we'd look real presentable to whoever picked us up."

**"WERE YOU ABLE** to talk with the plane that sighted you?"

"No, we didn't find our walkie-talkie right away. Funny, we found it when one of the boys went hunting among the survival gear for cigarets. Soon as we came up on the air we were answered by an Air Force plane and we talked pretty steadily with them until you fished us out. You know, that li'l rig sure is good for the old morale—I could see everyone in the raft sort of light up inside soon as we were answered, like when the travelogue is over and Jayne Mansfield comes on."

**"SAY, TELL ME,** I'd been told that your P2V breaks off somewhere near the tail when you ditch—you say it stayed afloat for 20 minutes and didn't break up?"

"This is one time the bird didn't break apart, Skipper. Most likely because our ditching was somewhat unorthodox. I'm gonna write in to APPROACH about it, although I'm sure they'll say 'it's interesting, but let's look further into the possibilities before recommending any changes in ditching SOP.' We ditched with gear down and no flaps.

"We had dropped the gear to prevent the starboard tire from exploding in the wheelwell. It was burning when it came down, but the airstream blew it out. I decided not to use flaps because things looked pretty well under control and I thought of the possibility of getting unbalanced flaps with all that fire out there. We retarded the good recip and the jets, turned parallel to the swells, and set up 200 feet per minute at about 125 knots.—

"Biggest thing I noticed on touchdown was we didn't do that bump-skipitty-BUMP that I was anticipating. We just hit once and stuck, and the deceleration wasn't nearly as much of a jolt as I'd expected.

"We began shipping water pretty quickly though. I went out my overhead hatch and the copilot pulled the raft release before climbing out."

"You think everyone did all he could then, to make your ditching successful?"

"Generally yes, I think everyone aboard contributed something, and no one got panicky or helpless. One of the men, in his eagerness to get out, got a bit shook when he found he couldn't get up, but he calmed down soon as he realized he just hadn't unbuckled his safety belt. I learned later, on the raft, that one of the men had loosened the water breaker just before the ditching—he said he wanted to be sure it would come loose when he went to remove it later. Luckily, it didn't come loose by itself, but I convinced him it wasn't the thing to do. He admitted he was wrong, and I think he did it just because he had no specific duty assigned and felt he *had* to do *something*—you know, same as the guy who runs around getting hot water while his wife is having a baby?—

**"WELL ANYWAY** skipper, I'm now a firm believer in survival equipment—and in submarines!—

"Here skipper, you keep this lighter, even though it doesn't work, it's got my name engraved on it so maybe you can put it in a trophy case or something. This is the first time it let me down, I used to win bets on it lighting the first time, just one spin and — HEY, looky skipper — it WORKS!" ●

# COMPRESSOR

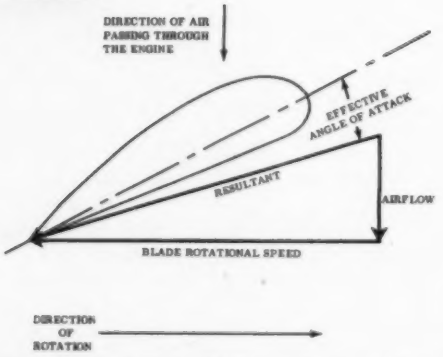



Figure 1. Compressor blade effective angle of attack, unstalled condition . . . a function of rotational speed of the blade and velocity of the air entering the compressor.

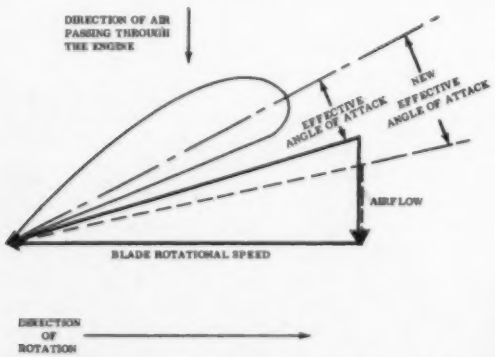



Figure 2. Effective angle of attack exceeds CL max of the compressor blade inducing a stalled condition . . . air velocity too slow for the rotational speed.

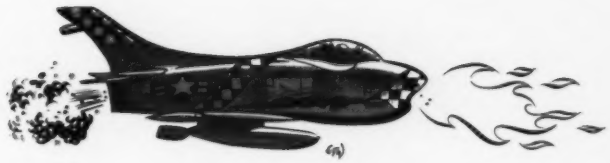
BACK in the early days of aviation—say the mid-1940's, there weren't many airplane drivers who didn't have the answer on stalls. You took an ancient fighter (F6F) up to some altitude above 5,000 feet, hauled back on the stick until she stopped flying, and you experienced stalling.

For a neat, snappy recovery, the antique aeronaut driving the F6F very astutely pushed forward on the stick and regained flying speed, with the air passing over the wings in a smooth laminar flow. He could then land and (over a game of acey-deucey) explain stalls to a neophyte who hadn't progressed so far in the syllabus: the angle of attack of the wing had been increased until it exceeded the maximum lift angle of attack; the air could no longer follow the contour of the wing so the flow separated from the upper surface. This set up a lot of turbulence and burbling which could only be eliminated by reducing the angle of attack.

What's that you say, Youngster? you don't even remember the F6F? and what's the relationship between the wing stall of that ancient fighter and the compressor stall in your J-999 jet engine?

Well each blade in the compressor section of the jet engine can be considered to be a minia-

# STALLS



ture wing—an airfoil. This is not quite so obvious in a centrifugal flow engine as it is in the axial flow type where the end view of each blade looks like a small sized reproduction of an F6F wing cross section. To do compressing type work, these compressor blades must produce *lift*, the same as a wing section. Lift develops a higher pressure underneath the airfoil than exists on the top of it, and pumps the air into the combustion section under pressure.

The multiple blades of the compressor are arranged in a circular band or bands around the shaft which couples the compresssor directly to the turbine. The amount of lift (hence, compression) developed depends upon the angle of attack of the blades, their speed (RPM), and the density of the air. In order to have a jet engine with a high output, low fuel consumption, and good acceleration, it's necessary to operate the compressor blades as near the top sub-stall limits as possible.

The hard part (and where the airplane wing differs most from the compressor blade) is that the blade is permanently fixed at some engineered angle and can't be changed during flight. (This may not be true next year, 'cause the engineers are working on the problem of variable pitch for the blades.) So a new factor must be considered — the effective angle of attack of the blades which is a vectorial solution of the flow (velocity) of the air into the compressor section and the rotational speed of the compressor. See Fig. 1.

But a turbo-jet engine doesn't operate just on compression; that's more in the realm of the big fan that used to be up in front on ancient fighters like the F6F.

For the jet, air is scooped in through the intakes, compressed, and fed into the burner cans where the temperature is increased by burning fuel. The heated air is directed through the turbine where its pressure and velocity are used to make the turbine go round (for the primary purpose of providing the power that makes the compressor go round in the first place).

Past the turbine, the hot gases are further expanded in the jet nozzle with the result that the tailpipe velocity is higher than the inlet scoop velocity. The difference in momentum between the incoming air and the outgoing gases is the thrust that makes the airplane go! About 85% of the power released by burning the fuel is used to make the turbine/compressor go round, and the other 15% pushes the airplane forward.

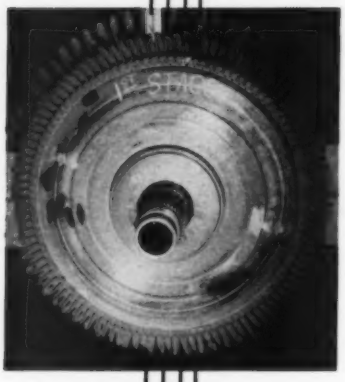
Since the turbine is coupled directly to the compressor, the power required by the compressor (plus accessory drive requirements and efficiency losses) must be exactly the same as the power produced by the turbine—otherwise engine RPM would go up or down or both.

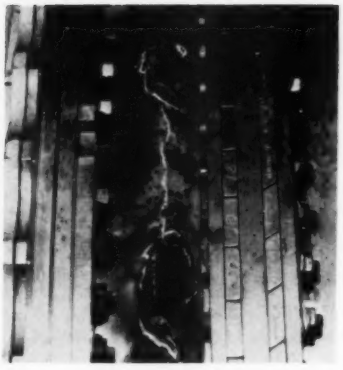
In flight, with the intake of air matched with the RPM, the stall angle of attack of the blades is not exceeded, the compressor is compressing, temperatures are under control, and all is well.

Throw an unbalanced force into the picture and all does not remain well! In general, there are two basic unbalancing forces which cause the compressor to stall. They are: 1) distortion of the air flow at the aircraft duct entrance or within the duct, and 2) excessive pressures in the combustion section of the engine, primarily the result of injecting too much fuel and building up a back pressure on the compressor exit which reduces the air velocity and mass flow through the compressor.

Note figure 2, which develops from figure 1 by either reducing the velocity of the inlet air and holding the same RPM, or by increasing the RPM and holding the same inlet air velocity.

The new effective angle of attack has gone over the hump on the lift curve and the blade is in a stalled condition. The air separates from the blade, creates





Left: Burned turbine blades caused by a hot stall . . .

Right: . . . failed turbine blades thrown out through shroud.

## COMPRESSOR STALLS

Continued

local turbulences that in turn produce back pressures that slow down the flow through the compressor section even more.

How can the critical angle of attack of the blades be exceeded?

**SLOW AIR** — Compressor inlet conditions can cause a slowing down of the incoming mass of air. The engine has been designed to function at a certain power level for a given RPM-airflow relationship. The engine will tolerate some amount of airflow loss due to ducting inefficiencies.

However, add to these inefficiencies any unusual airplane attitudes, airspeeds or throttle manipulations and the change in distribution of the incoming air at the inlet to the compressor (figure 3) can produce a compressor stall. The airflow variations between the high and low areas in figure 3 must be kept within reasonable limits or the compressor blades traveling between the areas may stall and unstall with such rapidity that a continuous stall will result.

Inlet duct in the jet wash of leading plane can stall the compressor . . .

At high altitudes the Reynolds Number of the compressor blade is much lower due to the lower density, and the blade has a much lower maximum lift coefficient—will stall at a lower angle of attack.

Low airspeed or skidding of the aircraft produces distortions of airflow. Supersonic flight may also adversely affect the ducting efficiency. The result, of course, is to increase the effective angle of attack of the blades and stall them out. This condition is usually a mild or cold type of stall and the pilot can recover by correcting the condition that set it up.

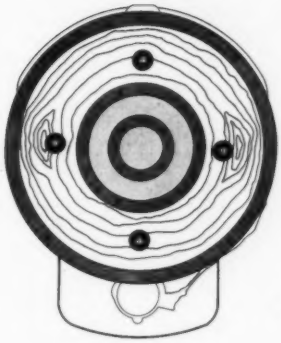
The most common method of encountering a cold stall is to establish a high RPM setting and pull the nose of the airplane up, hold it, and as the machmeter unwinds, kick in a little skid. As the air flowing into the engine slows down, the angle of attack on the blades goes up. Long before the wing of the plane stops flying, the compressor will be rumbling and grumbling.

**FAST THROTTLE** — A rapid increase in the turbine/compressor RPM produces the same result as slowing down the air. More important, jamming the

AREAS OF LOW INLET AIRFLOW

AREAS OF HIGH INLET AIRFLOW

Fig. 3



Cross-section of inlet duct . . . typical flow pattern of the air arriving at the compressor section.

throttle open (and not being saved by some fuel metering device) supplies additional heat and hence additional pressure in the combustion section. The higher pressure lowers the velocity of the air coming in from the compressor and builds up a back pressure. There is also the tendency to speed up the turbine/-compressor.

Here then is the most usual cause of a compressor stall: an increase in pressure at the compressor discharge! Too much fuel is supplied to the combustion system and the expanded gases cannot flow through the turbine nozzle fast enough, so the pressure "backs out" into the compressor.

As the air flow across the turbine diminishes, the engine fuel control senses an apparent engine underspeed and the maximum schedule of fuel is injected in an attempt to hold engine speed. This results in a more severe condition and the exhaust gas temperatures shoot right up to the limits, and beyond.

Recognize the unbalancing force that really fouls up the picture? Ordinarily the amount of fuel injected into the airstream is regulated by a governor which is sensitive to engine RPM. The engine starts to underspeed, more fuel is injected, higher back pressures increase the stall condition, more fuel—and a hot stall. This can result in a rich flameout (wet-out).

TACTICS—The flow of air into the compressor can be adversely affected by tactical requirements. Flying close formation (especially in column) may place the inlet scoop in the jet wash of the plane ahead, inducing a stall because of higher inlet temp, lower oxygen content and distorted air flow.

Sudden throttle movements, especially in formation, can stall the compressor.

Or when the plane's guns are fired, the muzzle blast can be scooped up by the intakes and set up air flow disturbances that create a stall. Similarly rocket exhaust distorts the air flow in addition to decreasing the oxygen content for combustion in the burners, hence enriching the fuel/air mixture.

A poorly executed formation join-up, if accompanied by a rapid retarding of the throttle and any jockeying for position, has all the elements for a pilot-induced compressor stall, in addition to the inherent dangers of a mid-air collision.

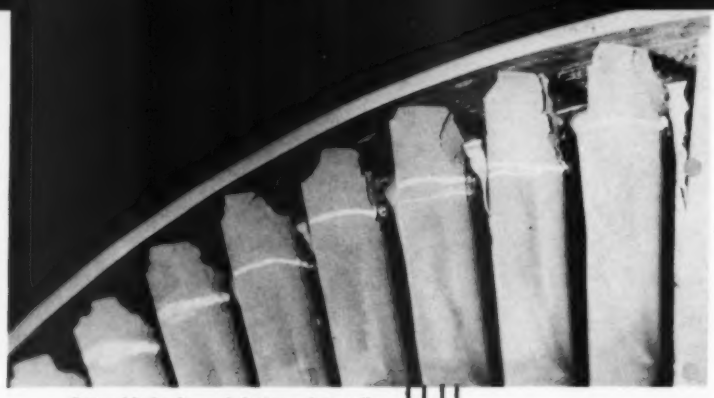
THE VILLIANS—The two real operational sources for this set-up are:

1. Pilot techniques in throttle control of the engine during acceleration especially in attitudes of flight which require high angles of attack and may have some sideslipping.

2. A malfunctioning or improperly adjusted fuel control.

With jet engines, the requirement for precise adjustment in trimming of the fuel control during acceleration of the engine is just as important as — if not more important than — any of the factors governing compressor stalls which are at the control of the pilot. It is vital that maintenance personnel realize the importance of proper trimming and adjustment of the fuel control!

Maintenance of fuel control—Figure 4 plots fuel flow vs. RPM, (showing fuel scheduling operating range) for a fuel control that is properly trimmed. For each jet engine with a particular installation and altitude, there are lines of fuel flow versus RPM which are established for 1) steady state operation, 2) compressor stall limits



Stator blades burned during a hot stall.

# COMPRESSOR STALLS Continued

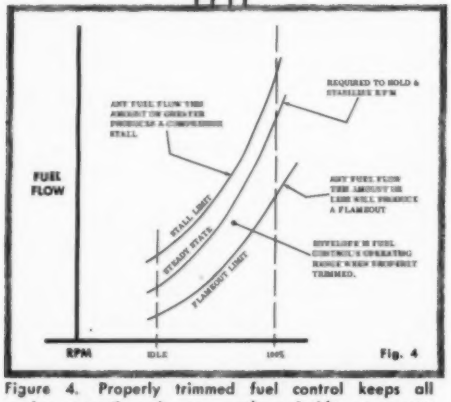
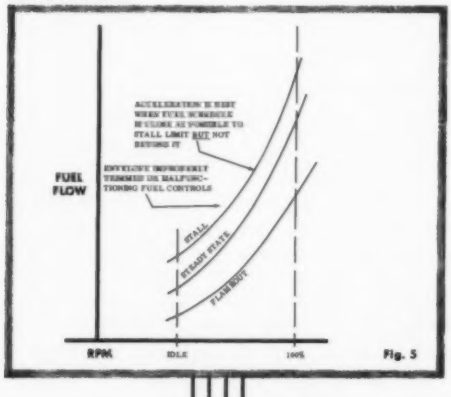

REQUIRED TO HOLD A STABILIZED RPM
ANY FUEL FLOW THIS AMOUNT OR GREATER PRODUCES A COMPRESSOR STALL
ANY FUEL FLOW THIS AMOUNT OR LESS WILL PRODUCE A FLAMEOUT
ENVELOPE OF FUEL CONTROL'S OPERATING RANGE WHEN PROPERLY TRIMMED.
FUEL FLOW
STALL LIMIT
STEADY STATE
FLAMEOUT LIMIT
RPM
IDLE
100%
Fig. 4

Figure 4. Properly trimmed fuel control keeps all engine operations in an envelope inside compressor stall/flameout limits.

Figure 5. A maintenance error in trimming the fuel control can provide too high a fuel flow during accelerations.




and 3) flameout limits.

The purpose of the fuel control is to operate the engine within the envelope from idle to 100%, eliminating the possibility of compressor stall or flameout during acceleration or deceleration of the engine.

In order *to improve the acceleration time* of the engine, the fuel control, by engineered design, must operate as close to the compressor stall limit as is physically possible.

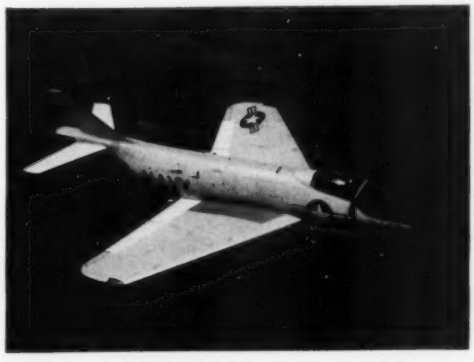
This would imply that a properly trimmed jet engine would be right on the ragged edge of a compressor stall at any full-blast acceleration. This is true. It is also true that a chopped throttle deceleration is right on the edge of a flameout.

The fuel control device must be capable of monitoring the fuel flow requirements on all acceleration and deceleration schedules, and also be able to maintain particular RPM as called for by the pilot's positioning of the throttle. Hence maintenance personnel, as well as pilots, must recognize their connection with compressor stalls. An improperly trimmed fuel control, as shown in figure 5, is as effective in causing a compressor stall as the spoiler strip (that you used to see on the leading edge of the wing of some ancient fighters) was in causing a section of the wing to stall out.

In some of the very modern high thrust, high efficiency jet engines, the difference between the compressor stall limit and the steady state fuel flow is ex-

tremely small in the range of RPM between idle and 90-95%. Once a stall starts, the engine usually will "hang up" at the 50 to 80% RPM range and the engine will not accelerate, although the throttle is in the full open position.

An engine which is improperly trimmed by the maintenance personnel on the ground can very easily be stalled by some flight condition or attitude which is common to the pilot in normal operations of the plane in the air.



Improper rigging which causes over-closure of exhaust nozzles can stall the compressor.

HOW TO RECOGNIZE A STALL—A compressor stall will make itself known! A loud explosion from a severe stall injected into the relatively quiet environment of the cockpit can scare the g-suit right off the pilot. Lesser stalls may produce a rumbling, a "woof," or even a whistle. It is also possible to experience a very mild stall that isn't evident by instrument. Engine vibration will be noted along with a possible decreasing RPM. There will generally be an increasing TOT and flame or smoke can billow from the tailcone or even from the air inlet ducts.

Compressor stalls are more frequent in cold weather operations because the stall margin is decreased. Engines equipped with anti-icing systems are more prone to stall when this system is in use.

HOW TO AVOID A STALL—You can avoid compressor stalls by knowing what causes them and closely observing the following points:

- Have the fuel metering control properly rigged before take-off.
- ALWAYS treat the throttle with respect—no erratic movements
- Coordinate flying to help inlet duct efficiency
- Climb on the climb schedule.

HOW TO GET UNSTALLED—If the compressor stall occurs during subsonic flight; simultaneously:

- Retard the throttle until the stall ceases or IDLE position is reached.
- Decrease the angle of attack of the aircraft
- Correct any abnormal attitude of the aircraft, including any sideslip
- Reduce altitude and get into a more dense atmosphere

If the stall occurs during supersonic flight:

- Terminate afterburning and retard the throttle to IDLE
- If necessary, reduce altitude and establish high subsonic airspeed.
- Attain a normal aircraft attitude, low angle of attack and no sideslip
- Do not manipulate the throttle until normal operation of the engine has been obtained

The engine reaction to a compressor stall may be a flameout. After correction of the conditions which induced the stalled compressor, and after insuring that the stall was not maintained to the point of overtemping or other engine damage, go through the normal re-light procedures. KNOW YOUR AIRPLANE'S FLAMEOUT PROCEDURES — and avoid compressor stalls!

Approach *wishes to acknowledge use of material from the Aeronautical Engineering Manual, used in the USC Safety Officers course, and given to all Navy graduates; as well as figures 1, 2, 3 and other information from USAF* Flying Safety, *May 1955.*

The purpose of Anymouse Reports is to help prevent or overcome dangerous situations. They are submitted by Naval and Marine Corps aviation personnel who have had hairy or unsafe flight experiences. As the name indicates these reports need not be signed. Forms for writing Anymouse Reports and mailing envelopes are available in readyrooms and line shacks. All reports are considered for appropriate action. Please send your reports to the Naval Aviation Safety Center, NAS, Norfolk 11, Va., now!

## RIGHT-OF-WAY

"RETURNING to an advanced base from a 12-hour tactical flight, I was properly cleared by the tower and lined up on downwind leg. A *Beech* on a local flight called for landing and was cleared to downwind leg behind the 'P2V now on downwind' (me). I saw the *Beech* as I approached the 180-degree spot too, but at right angles to me and the runway (apparently on a wide base leg).

"The tower advised him he was cleared *after* the P2V; he then turned sharp left, right into me at the same altitude, and heading the wrong way on the downwind leg. As I started to add power and haul back the yoke, the *Beech* dove sharply and passed under me—barely!

"The *Beech* pilots' faces were clear and close, as was the number. The incident was reported but without any action taken (Tower and *Beech* were not USN). Corrective action would be to insure adherence by all pilots to the course rules and tower instructions—always a continuing source of near misses—and better lookout by pilots entering patterns."

## BUSY BEES

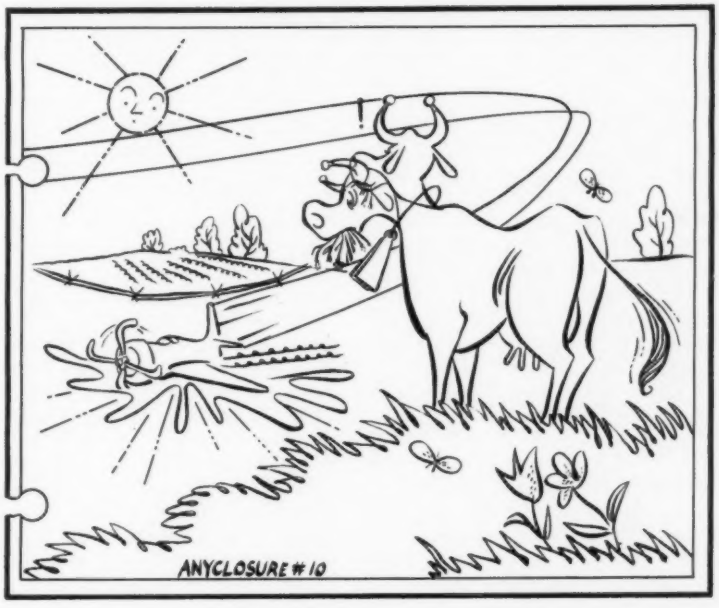
"IT WAS one of those beautiful spring mornings with the birds singing and the bees buzzing. This intrepid aviator felt it was a good day to log some easy flying time in a P4Y.

"During takeoff, at about 80 knots, I eased the nose off and shortly after indicating 100 knots the airplane flew itself gently off the ground. Climbing out, with the gear coming up and at over 200 feet altitude, I started reducing power. Suddenly I noticed the airspeed was 115 knots and dropping slowly. I left takeoff power on and flattened the climb to level flight. Adding to my worries was the fact I was crossing over the admiral's quarters at 300 feet with takeoff power rattling the windows.

"By now the airspeed was down to 80 knots and I knew the airplane wouldn't fly that slow, yet I had good response from all controls.

"While looking for the panic button, I switched from static pressure to alternate and airspeed climbed quickly to 145 knots. Once again it was one of those beautiful spring mornings with the birds singing and the bees buzzing and those four fans roaring sweetly. A postflight inspection revealed a couple dozen clover leaves packed in the static vent line by those busy bees."

*We know it isn't spring and all, but water and freezing temperatures can do the same thing to your airspeed indicator—Headmouse.*




## THANKS

"ON RETURN from an FCLP hop in an AD-6, the engine failed after the 180-degree position. I couldn't make the field because of a wide pattern. All during the hop (1.9 hours) there was no indication of impending failure. The plane sounded fine and all engine instruments were normal. The engine just snorted once or twice and quit.

"I was at about 900 feet and 120 knots. I knew I couldn't make the runway, so I pulled up the gear and concentrated on putting the airplane in a cow pasture just short of the field.

"There was a loud whump and much flying dirt as the airplane ground to a stop in 198 feet. I had landed gear up, flaps down and with approximately 95 knots.

"I want to take this opportunity to say that I owe my life to the emergency procedures pounded into me in flight school and no less to the safety equipment in the airplane and hung on me—in particular the lap belt, shoulder straps, and that APH-5 helmet. Thanks."

## GOING DOWN

"I WAS flying a T-28C to qualify for carrier arrested landing I was taxied off the wires to the launching position. I was intent on watching the launching officer and did not notice that I was aligned somewhat to the left of the axial deck.

"On the launch signal I proceeded to take off in the direction of my aircraft alignment. For a second or two I blindly followed the center line of the angled deck (they have one for training command now, in case you're wondering). When I realized what was happening it was too late to turn back to the axial deck and too late to stop.

"Over I went, and the aircraft sank below the level of the number 2 elevator like I had driven a truck off a cliff. I smoothly raised the nose to a landing attitude and held on. Luckily, I never touched water. I made the rest of my launches off the axial deck—it felt like a 10,000-foot runway. That aircraft sure will do amazing things."

## CHARLIE, OR DELTA?

"AS IS the case in many accidents or near-misses, this one started the night before. With a two-week old baby in the house, and Granny departing a few days before, I decided it was time to give the wife a night off from the ups and downs required for bottle feeding. It was a good time for it, since we had no flights scheduled for the following day. So after retiring at 2230, I was up for an hour at 0200 and up for good at 0515.

"A slightly fuzzy feeling developed during the morning, but nothing serious. Need for a project flight also developed (priority A), and I was elected from a field of one to take an AD and fly it. I was aware of the many aero-medical reports on flying in less than a peak-efficiency condition, but I felt I was capable of handling the rather simple requirements of this particular flight.

After takeoff at 1530 and a nor-

**anymouse**
**and his hairy tales**

Continued

mal operation consisting of 10-degree dives on the station, I was released to tower at 1625. At this time I was completing a dive, and a slight right turn put me in the landing pattern at the 180-degree position. I raised the dive flaps and proceeded with the landing check-list, continuing around the pattern for a complete circle before landing.

The list was complete except for wheels, flaps, prop and canopy when I turned downwind, at which time I called my position to tower. My ears had failed to clear from the last dive, and were paining slightly, but the decision was made to land before clearing them, rather than having to remove oxygen mask and change mikes. Further distraction was experienced when a friend called waiting instructions to the tower regarding his ride home. We ride together, and I was thinking how fortunate it was that the driver would not have to wait long for either of us.

During this conversation (the tower had to have several repeats) I put the dive flap lever down for wheels. This satisfied the need to push a lever down. Just prior to turning base, I put the flaps down and pushed the prop to 2600 rpm. While informing tower that I was turning base leg, a swift decision was made not to include the usual phrase, "Gear-down-and-locked," in my transmission; and at the same time I looked at the wheel-flap indicator, clearly saw three UP's, and accepted this as normal. I had completed the list except for canopy, and had checked the gear.

While on base leg, I intermittently applied nose-up trim, but on roll-out to final I realized that I was not getting what I wanted. "The dive-flap-trim solenoid must have stuck in when I raised the dive flaps," was my thought, so I looked down to check the situation. Looking at the trim indicator, I applied nose-up trim and confirmed my feeling that the trim was not working. A glance at the solenoid button also included the dive flap handle — "DOWN!"

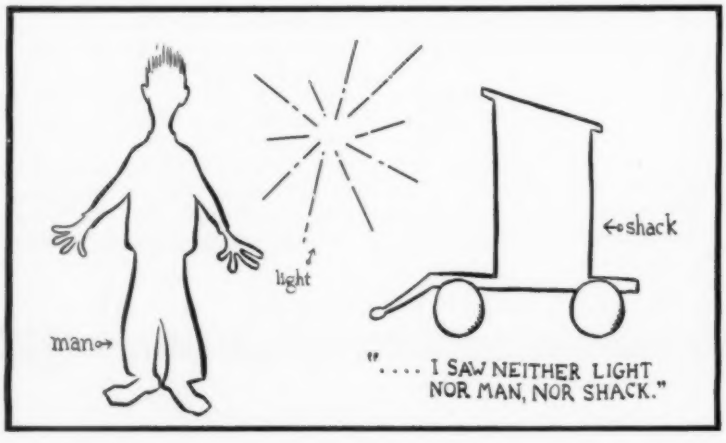
I retracted the dive flaps and pondered for the next several seconds the question, "How could I have been so stupid as to leave the dive flaps down through dive pull-out, checkoff list, and a full circuit around the field?" This question was dismissed with an all's-well-that-ends-well feeling, and I spent the remaining second or two of final patting myself on the back for catching the error in time to save the bottom flap.

This series of events, head in cockpit, probably prevented my usual observing of the wheel watch, who claims to have given a red light. I saw neither light, nor man, nor shack. Flares were available, but were not used. I flattened out, a little fast, but was not concerned since the runway is plenty long to kill off the extra speed before touching down.

When four to six feet off the runway, I heard the tower transmit "_____take it around, you have no gear." Response was immediate, unquestioning. I shoved the throttle forward. The AD purred like a Singer, and I didn't settle another tenth of an inch. (You may keep your jets.) First thought while applying power was, "The confounded gear didn't go down." I glanced at the gear handle while thinking this, but didn't believe what I saw. A second or two later, after another look, the sickening truth pounded through—the gear handle was UP.

I won't sum up the situation thus far, leaving you to make your own summary and analysis, for the point I want to make is yet to come.

Until I shoved the throttle forward, I had plenty of troubles. With power on and climbing, my troubles were over. So much for the physical aspect. Mentally, just the reverse is true, for with application of power my troubles began. Shock. Sickening realization of what had almost happened to a costly missile,



an equally expensive instrumentation pod, and an AD-6, swept over me like a Notre Dame line . . .

These thoughts were quickly replaced with an involuntary, rapid analysis of what had happened and why. It was only with extreme effort at concentration that I was able to complete the checklist items and accomplish the job at hand. If preoccupation contributed to the first situation, it was doubly present now. Again, I did not look for, or see the wheel watch. One would think this, certainly, would not be missed on the second approach. The battle between present and past continued throughout approach, landing, rollout, and taxi-in. Usually I lean the mixture, turn off fuel boost, check the cowls open, shove the prop into full low pitch, and raise the flaps immediately after turning off the runway. The mixture got leaned, but I do not remember doing it. The fuel boost remained ON, and I did not check the cowl flaps open. The prop remained at the 2600 rpm position.

Approximately two minutes after leaving the runway, I consciously, deliberately raised the flaps, noting with certainty that I was not actuating the wheel lever. Upon reaching my parking spot, I shut down the engine, automatically using the correct procedure, and relaxed. The last act was over, but during the entire second pass I had felt as though I were being put under an anesthetic against my will. A constant fight was necessary to remain out of the postflight analysis business and concentrate on the simple procedures attendant to flight completion.

During the hours following, while mowing the lawn, enjoying a good supper, playing with the kids, and helping with the formula, my mind dwelt several times, briefly, on the afternoon's incident. But not until 2230, as my head hit the pillow, did the final curtain call take place. I tried to remember turning gas and switch off, but could not. A check the following morning revealed Mags on BOTH, fuel MAIN.

Here is my point. Subsequent to the waveoff, a supreme effort was required to prevent an accident. This effort was successful. But, even so, eight mistakes were made. Little ones, inconsequential, to be sure, but how far removed were they from mistakes that could have been accidents? I am quite sure that I sounded cool as a Cadillac convertible to the tower, but audible reaction is not always a mirror of the thoughts within.

Would it be better, in a case such as this, for the tower to refuse clearance for a second approach until, say, 10 minutes have passed? Or would this interval agitate, rather than appease the pilot's emotions? A thought-collecting interval is the answer for me, and the next time (NO!) I shall voluntarily fly for such an interval before making the second try.

*Headmouse reports controversy on the delay suggestion. It appears to be an individual and/or a command situation whether your signal is Charlie or Delta.*

Anymouse and Headmouse often assist in special projects of the Naval Aviation Safety Center. For this reason they would like from you via Anymouse Report forms or official letters any ideas and experiences not previously reported concerning . . .

- my personal system for keeping myself trained for emergency situations — engine out, ejection, electrical failure, etc.—

- fuel contamination incidents and additional suggestions to prevent catastrophic accidents—
- suggestions for **Approach** articles you would like to see—
- foreign object damage control tips—
- design deficiencies (operational or maintenance) which continue to recur in new aircraft, though reported as problem areas on previous models—
- search and rescue procedures and suggestions—
- Murphy designs (maintenance, cockpit, or personal equipment) —
- Procedures and techniques used for recovery under "mirror out" conditions—

# HEADMOUSE

Have you a question concerning aviation safety? Send it in to Headmouse on an Anymouse Report and he'll do his best to help.

### ON THE HIGH SIDE

Dear Headmouse:

Your article "On Handling High Pressure Air," December 1956 *Approach*, points up a very dangerous situation. Information available to me as a result of an investigation indicates that this malpractice is Navy-wide. Dollars to doughnuts you will find high pressure air being used aboard any naval air station or any aircraft carrier where the required tire pressure is in excess of 250 psi.

Perhaps you can use your influence to have TO 52-50 brought up to date. In my opinion it should spell out what equipment is available and should be used to inflate tires above 250 psi. Believe it or not, there are very few air bowsers in the Navy with this capability. For example, if the one you illustrate in your article is an R11C-1150, it cannot do the job. The regular practice with this compressor is to use high pressure air and a low pressure gage when inflating tires.

The only two "legal" methods of inflating a tire to above 250 psi involve the use of either the R11C-1185 compressor or the R51C-12450 air bottle. The 1185 compressors are few and far between, and the 12450 air bottle has only recently been available although it has been published in the Section G allowance since November 1954.

It is strongly recommended that the availability of the 12450 air bottle be given wide dissemination. It is further recommended that TOs and instructions pertaining to safety be revised and reissued at least annually. This will help bring these matters to the attention of those who need to know.

INVESTIGATING MOUSE

*Regulators are being procured for installation on the high side of the R11C-1150 air compressor so that the operator can manually regulate the amount of pressure he requires for the item he is servicing. These regulators are being procured against fiscal 1957 funds and should be available shortly.*

*A new type of air compressor, the R11C-1185, has a higher pressure capability. It is being procured in increasing numbers from the fiscal 1957 and 1958 funds. This air compressor requires, and already has, a regulator on the low pressure side of the unit. This low pressure side should be used with Gaging - Inflating device R8G392-500N (Section U item) for the inflation of tires and struts. A regulator for the high pressure side is currently under procurement out of 1957 funds.*

*Regarding the reissue or revision of Technical Orders concerning safety precautions and operating instruction for various compressors, BuAer does not feel that an expenditure of time and funds is warranted. Ground Handling Equipment Unit states that the Bureau has found the Technical Order system ineffective and is considering issuing another type of maintenance directive specifically for working maintenance personnel. It is not expected, however, that this new type of directive will be forthcoming in the near future.*

*In the meantime, it is recommended that maintenance personnel using the various equipment completely familiarize themselves with the equipment and its safety precautions through use of the handbooks which are provided with each unit.*

*Very resp'y*
*Headmouse*

### BANSHEE BLOWOUT

Dear Headmouse:

HERE ARE SOME NOTES ON CANOPY MALFUNCTION AND EXPLOSIVE DECOMPRESSION:

Aircraft involved: F2H-2, USNR
F2H-1; NACA

The explosive decompression was the second such experience for the writer. The first one being in daylight hours following the flameout of both engines of an F2H-1 at 42,000 feet. This second experience was at night on top of a stationary front with a DVFR flight plan.

*Things in common were:*
*Pressure breathing and lung expulsion of air tended to push the mask off the face.*
*Dirt, dust and debris filled the air momentarily (cockpits of pressurized airplanes should be kept extra clean).*
*It gets very cold very quickly particularly when the canopy is moved back 4 to 6 inches on the F2H-2.*
*Canopy frosts up quite fast all over.*

The F2H-1 was dived at limiting speeds through a 25,000 feet overcast and then restarted at 12,000 feet while circling over Chincoteague NAS. No physical after effects were noticed.

The F2H-2 decompression occurred at night. Confusion level is magnified due to darkness.

The external switch did not function properly in Memphis, therefore,

the emergency opening procedure was employed.

The canopy was re-activated to the normal operation status, presumably by reference to T.O. instructions.

During the afternoon climbout to altitude the canopy popped back about six inches on the track while indicating about 330 knots at 20,000 feet. Airplane was slowed down to 250 knots and canopy closed—flight was continued without pressurization at 25,000 feet to NAS Cecil.

A request was made at Cecil Field for better adjustment of the canopy. Qualified personnel on the F2H-2 type airplane reported that some re-adjustment of the canopy had been accomplished.

No thought was given that explosive decompression was a possibility after the second canopy adjustment was accomplished. I did not know just exactly what work was performed, nor at the time was much concerned, considering the technicians were qualified to handle the details and I would do the flying —*this is a basic mistake when one is away from home*—since I could not later tell my own mechanics anything except — "the canopy popped open at 39,000 feet".

The elements of coldness, draft and noise complicated the navigation which had to be continued—since radio contact could not be established. In my favor was a carefully worked out navigation log which minimized the task. The primary reason the ground stations could not be contacted was that the mask could not be adjusted tight enough to balance the pressure of the oxygen. Considerable moisture gathered in the mask very soon, possibly due to decompression saliva and breath moisture—the exhalation valve appeared to be frozen up or stuck. All oxygen was exhaled along the sides of the mask. This made transmissions impossible.

The entire canopy frosted over and after about 10 to 15 minutes, I had to descend due to cold—confusion and fear of anoxia onset—thinking back on the experience—hypoxia could have been occurring to cause the confused ability to think clearly and slight dizziness. Finally survival became an issue—The dive out to 20,000 feet was done with reluctance since no contact with a ground station was possible. The canopy was closed at 200 knots and 20,000 feet and full heat was applied for several minutes.

The G-suit inflated—on decompression—apparently it became disconnected sometime after the flight started—had to be released later by holding in the valve on the trunk of the suit. If suit had been connected, this lower abdominal pressure could have been avoided.

Post flight examination showed no ear or throat damage—intestines were a little sore for one day.

Flight clothing worn was 10-inch boots, G-suit, summer coveralls, summer gloves, Mae West, and hard-hat with mask and chinstrap.

W. L. ALFORD
CDR-USNR-R
Aeronautical Research
Engineer-Pilot, NACA

*Such reports help the pilot's and medics general store of knowledge. Any others?—Headmouse*

**TWO FOR ONE**

Dear Headmouse:

(1) Attempted to procure a new or clean flight suit.

(2) Why? It stank—from grease, dirt, and sweat from recent CV landings on hot summer nights!

(3) As previously noted, I attempted to get a new or reconditioned flight suit from (a) squadron paraloft and (b) squadron supply. Source (a) reported that there were none in the pool to fit (I wear common size 40M plus the fact that there were only three suits in the flight gear pool). Source (b) reported that I would have to turn in old one to get new one and the processing of paper in squadron and main supply would take one week (price of new OR reconditioned flight suit is $10.70 and is now chargeable to rapidly diminishing BRAVO allotment). Squadron supply officer very reluctant to sign forms.

(4) Results? Ziltch! I either wear dirty, sweaty one—don't fly for a week or, let spouse toss in the Bendix and lose that valuable fire protection mentioned in recent *Approach* articles.

(5) Next time? Try not to lose my temper again and continue to wash my own flight suit and continue to lose fire protection.

(6) Recommendations? (a) Change present BuAer squadron allowances on flight gear to provide enough flight suits for a workable flight gear pool or, (b) change present policy to allow pilots to have *two* flight suits on logbook custody to provide for cleaning of one and flying in the other!

Very Respectfully,
ANYSKUNK

P.S. I smell more like a skunk than ANYMOUSE!

*NASC forwards all such recommendations on personal equipment (less identification) to the appropriate BuAer slot. While some of these recommendations are in the mill, many are merely chipping readyroom walls (see page 24 of this issue). Meanwhile, check the latest word on availability, page 32 October* APPROACH. *And, in addition to Anymouse Reports, suggest that unit commanding officers also forward official letters citing the valid operational requirements for such recommendations as two flight suits.—Headmouse*

A DIGEST OF SIGNIFICANT AIRCRAFT ACCIDENTS

# truth and consequences

**HORSE SENSE WITH HORSEPOWER**—While filing his flight plan at a far northern base, the P2V-5F pilot inquired about runway and taxiway conditions. He was informed that the snow had been removed but that large patches of slippery wet ice were present on the taxiway to the duty runway.

It was about 0730, still dark, when the P2V eased out of the parking area and moved slowly along a taxiway toward the turnup mat and the duty runway. Twilight did not begin 'til 0746 and an overcast at 4000 feet contributed to the darkness. Landing lights were used while taxiing. All taxiways and turnup mats were clearly marked and well lighted by blue lights and separate reflectors.

Upon reaching the turnup mat, a large square area extending out to the left of the taxiway, the pilot selected a spot on the extreme left. This spot was well within the boundary lights and his intention was to leave room for following planes to make their runups. Landing lights were secured prior to beginning the engine runups.

With the engine check complete at about 0740, the pilot started back to the taxiway. The first light of dawn allowed a limited amount of vision but was not adequate for clear perception. He saw caterpillar tractor tracks through the snow ahead and elected to follow the tracks.

After rolling about 75 feet the pilot was ready to make a left

## WHIZ QUIZ

IF YOU haven't won at acey-deucey, baccarat or five-card draw lately, here's your chance to come out a winner. If you score on all 12, you're real great. And if you miss one or more, well, you *could* have gotten them all right! In either case, try your brain-box on these and if competition stimulates you to greater effort, let the loser buy the doughnuts (not recommended where such wagering is prohibited).

1. Passengers without oxygen may NOT be transported above 10,000 feet. TRUE or FALSE?
2. You *may* make a 15-minute passenger stop on a DVFR flight plan IF you are certain that weight & balance will remain within limits. TRUE or FALSE?

Twilight and an unmarked snow drift on the ramp set the stage.

turn back onto the taxiway when the plane came to an unexpected stop; the starboard wheel had run into a three-foot snow drift.

Without checking too closely the pilot attempted reverse thrust in an effort to back out. Two attempts were unsuccessful. Only the starboard wheel appeared stuck as the nosewheel had ridden up on the snow and the port wheel was on six inches of snow so at this point the pilot tried forward thrust. The nosewheel dug in and then the starboard prop and radome were damaged from hitting the snow.

This narrow, unmarked snow drift blocked the entrance to the turnup mat for approximately 85 feet and extended in a direction parallel to the taxiway. The error was divided between the base and pilot. It was considered that a pilot could normally expect such a snow drift to have been removed or at least marked, lighted, or its presence made known by base ops or tower personnel. The last snow fall of an appreciable amount (one inch) had fallen *12 days* earlier!

At the time the plane was first halted by the snow drift no damage had been done. This is a situation which applies in many accidents where the initial act is running into sand, soft earth or mud, or snow, and the last act is the submission of an accident report because the pilot tried to get unstuck by horsepower rather than horse sense.

More briefs next page

3. If the man told you the green avgas he was pumping into your plane was 115/145 octane you'd say, "Heck no, you're wrong, it's_____."
4. Weather sequence reports, which used to be issued hourly on the half hour, are now issued on the hour. TRUE or FALSE?
5. The U.S. Naval Aviation Safety Center handles all flying safety matters for U.S. Army aviation. TRUE or FALSE?
6. *Graupel* is (a) snow pellets, (b) a clam-shaped helicopter rescue net, (c) cinder-like material used for drainage alongside runways.
7. You're flying along in CAVU but everything on the ground is covered with much snow and ice. What hazard *in the air* would you be careful of because of that condition?
8. You have filed IFR and requested 6000'. You receive "ATC clears Navy _____ via flight plan route," is this clearance complete?
9. The proper abbreviation for liquid oxygen is Lq Ox, or LOX?
10. When necessary to file by radio, is it permissible to indicate that a list of your passengers and crew is on file at your point of departure?
11. If faced with fire in upholstery and given the choice of a $CO_2$ or a water extinguisher, which would you use? Why?
12. When you're IFR on top you're just as responsible for keeping a lookout for other aircraft as when you're VFR. TRUE or FALSE?
13. Your ETE is your planned time from takeoff to _____ at destination.

See page 22 for answers.

# truth and consequences

Continued

**DAYTIME NIGHTMARE** — A pilot with 2300 total hours was assigned to ferry an SNB and though he had 120 hours in the *Beech* he had only 1.7 in the last 12 months. The plane captain was to act as observer in the right seat.

Takeoff and climbout to 8000 on top was made on the right main tank, according to the pilot's statement. This took 15 minutes and then fast cruise power was set up. The fuel gage selector was then set on the left auxiliary position and noted to read full. After about 12 minutes cruise, both engines quit without warning.

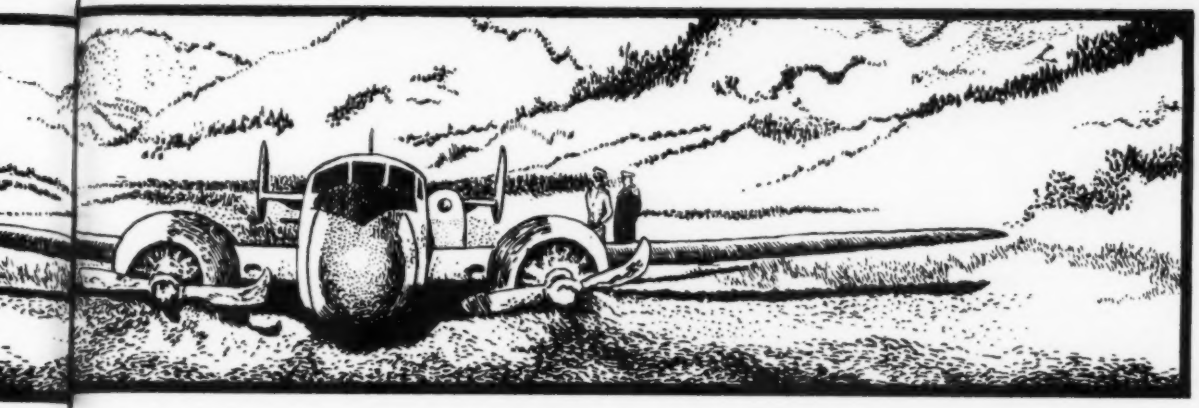
The cloud tops extended to 6000 feet and the ground below was mountainous with elevations from 1000 to 5900 feet. First corrective action in the cockpit was to apply FULL carburetor heat followed by FULL RICH on the mixtures.

Second corrective action, after noting ZERO fuel pressure on both engines, was to select the right main tank and operate the wobble pump for about 30 to 45 seconds. The fuel selector valve was then shifted to left main and the wobble pump was worked furiously for another 30 to 45 seconds. By then the SNB was in the soup and no further attempts, other than pumping the throttles, were made to start the engines, due to the necessity of gliding down on instruments.

The altimeter wound down through 2000 feet of clouds and when it read 3700 feet the pilot

**Answers to Whiz Quiz (Page 20)**

1. You can take 'em to 12,000 if required for safety of flight. OPNAVINST 3710.7A.
2. Not on a DVFR. You'll have to re-file. OPNAVINST 3710.7A.
3. 100/130, of course. See *Approach*, March 1956.
4. Became effective 1 June 1957. See "Airman's Guide."
5. The Center collaborates with the Army, in fact, Major D. A. Hill, USA, recently reported to NASC. The Army's Aviation Safety Board is at Fort Rucker, Alabama.
6. The All-Weather Flight Manual says graupel is (a) snow pellets, a mushy mass of water and snow and is a source of rapidly forming ice. One source reported accumulating 1½ inches in less than 15 seconds.
7. We assume you'd be looking out for other aircraft and everything else you'd do normally, but also be alert for possible changes in the directional courses of radio beams when the towers are known to be coated with ice. See AWFM.
8. Not quite, for you still need to be assigned an altitude when cleared via flight plan route. Check your Flight Info Manual.
9. Check your RadFac for this one, under Directory Of Aerodromes.
10. Sure, but check OPNAVINST 3710.7A to see when you can file in the air. You must request and receive assurance that your flight plan will be relayed to a military guard agency.
11. Being a carbonaceous material, the upholstery would need a lot of $CO_2$, the water (or coffee) would normally work better. Then too, if you used up the $CO_2$ on this fire the water wouldn't be very effective on an electrical or hy-



With both engines out, the pilot glided down through the overcast and broke out in a small valley in the mountains.

broke out in a small valley under a 200-foot ceiling. He saw a level spot to starboard and a hill directly ahead. Pulling up into a semiwingover to the right, he went up into the overcast then broke out again and landed straight ahead in an open field with no injuries to himself or his observer.

One of the accident board's conclusions was that the pilot "exhibited the highest qualities of airmanship upon attaining visual contact with the ground."

draulic fire later!

12. Absolutely TRUE, since you'd hit the ground just as hard from a mid-air collision whether you're IFR or VFR, it's mighty good insurance to always keep a sharp lookout whenever you can see beyond your wingtips.

How'd you do? Had to buy the doughnuts? We hope that's the most it will ever cost you, as some of these answers were learned the very very hard way by pilots and crewmen who initaled the Required Reading board without looking to see what it was they were signing away.

The salvage party found that the right and left main tanks and the left auxiliary tank were nearly full. The right aux tank was EMPTY. By utilizing the wobble pump it was possible to register fuel pressure on both engine gages, except on the right aux tank of course. Gasoline was added to this tank and pressure readings were obtained by the wobble pump.

The flight was duplicated in another *Beech*. Takeoff, climb to 8000 and cruise was made on the right auxiliary tank. After 29 minutes, both fuel pressure gages registered a loss of pressure. It was approximately 10 seconds before the wobble pump built up fuel pressure and kept it constant. During this flight, it was found that fuel pressure would remain constant when the fuel selector valve was positioned midway betwen two tanks containing fuel but, when positioned midway between a full and an empty tank, a slow fuel pressure loss on both engines was noted in approximately 5 seconds.

During the investigation, the plane captain was asked to diagram the fuel selector valve set to the right main tank. He positioned the valve to the right auxiliary tank.

Primary error, according to the board, was pilot technique and that fuel starvation was experienced as a result of a dry tank. The most logical conclusion is that takeoff was made on the right aux tank with the pilot believing he was on the right main. It was also concluded that upon reaching cruising altitude he shifted the fuel gage selector switch to the left aux tank, but before he shifted the fuel tank selector valve, he was interrupted and later forgot to shift this valve.

The board is of the opinion he did not remain on a full tank long enough for the wobble pump to completely clear the fuel lines of air.

**ADF PROBLEM**—The experienced TV-2 pilot commenced a penetration to a west coast air station with the weather 3000 overcast and 12 miles visibility. The homer associated with the penetration is located in mountains south of the station and the minimum altitude before station passage inbound is 5500 feet.

At 1137 the approach controller received a report that the pilot was in a procedure turn at

Continued

*The following is true. Only the name has been changed to avoid recriminations.*

## SAVE A LIFE

SUBMIT AN

# ANYMOUSE

ANONYMOUS REPORT OF HAZARDOUS EXPERIENCE IN AIRCRAFT

TIME & DATE AUGUST 1957 AIRCRAFT TYPE & MODEL ANY

CHECK AS APPLICABLE:

**TYPE FLIGHT:** TRAINING ☐ SERVICE ☑ COMBAT ☐
**CLEARANCE ISSUED:** VFR ☐ IFR ☐ **ACTUAL WEATHER:** VFR ☑ IFR ☐
**MANEUVER INVOLVED:** TURN-UP ☑ TAXIING ☑ TAKE-OFF ☐ CLIMB ☐ CRUISE ☐
DESCENT ☐ APPROACH ☐ LANDING ☐ ROLLOUT ☐ TACTICS ☐
**POSITION IN AIRCRAFT:** PILOT ☐ CO-PILOT ☐ NAVIGATOR ☐ FLIGHT ENGINEER ☐
RADAR OPERATOR ☐ GUNNER ☐ OTHER ☐

**NARRATIVE:** Give details such as: (1) What happened? (2) Why? (3) What did you do? (4) Results. (5) What would you do next time you were in a similar situation? (6) Recommendations to prevent or reduce hazard of similiar incidents. Use both sides of this sheet, if necessary. Mail in attached envelope IMMEDIATELY. No stamp required. NO SIGNATURE OR APPROVAL REQUIRED.

WENT OVER TO FLIGHT GEAR ISSUE AT NAS GOTNOMO' FOR THE 3ED TIME TO GET CRASH HELMET (YE OLDE HARD HAT, H-5 TYPE). FOR THIRD TIME, NONE (IN MY SIZE – MEDIUM) WERE AVAILABLE. IN MY OPINION THE NAVAL AVIATION SAFETY PEOPLE ARE A BUNCH OF LIARS OR THE NAVAL AVIATION SUPPLY PEOPLE ARE TOTALLY INCOMPETENT. PROTECTIVE EQUIPMENT FOR PILOTS SHOULD BE READILY AVAILABLE AT ALL TIMES IF THE FLIGHT SAFETY PROGRAM IS TO BE EFFECTIVE TO ANY DEGREE. AS FOR NON-PROTECTIVE FLIGHT CLOTHING, THE SITUATION IS SO BAD I CAN'T EVEN GET AS MAD AS I HAVE IN THE PREVIOUS PARAGRAPH.

P.S. PUBLISH THIS AND I'LL BE GLAD TO SIGN IT!

SHO 3548(New 9/53) NAVY—OPPO SHO Norva

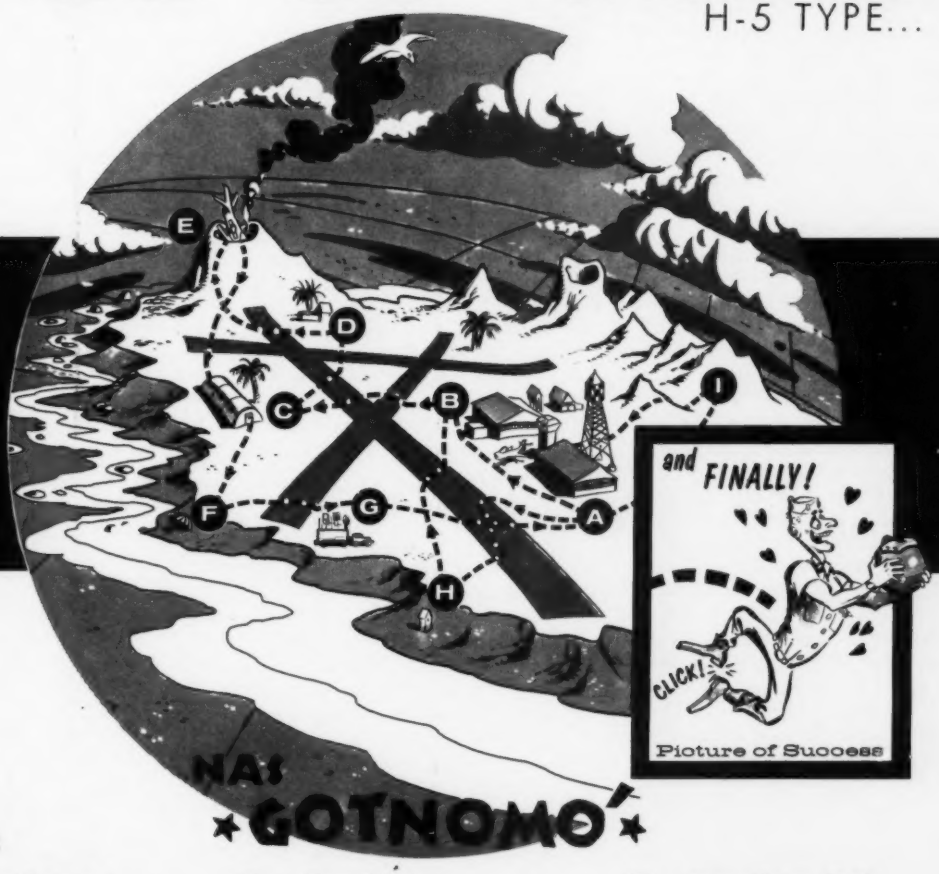
Admittedly, your Anymouse Report and other similar correspondence point to some bad local situations. But it is known that some pilots have gotten theirs by going "above and beyond" the gent in the gear cage.

—Very Resp'y Headmouse

## ENSIGN PETE PERSISTANCE AND THE

# POT OF GOLD

H-5 TYPE...




**LEGEND:**

| | | | | | |
|---|---|---|---|---|---|
| A. | Readyroom | D. | Pay Clerk | G. | Squadron C.O. |
| B. | Gear cage (striker) | E. | Aviation Safety Officer | H. | CAG |
| C. | Chief Storekeeper | F. | Aviation Supply Officer | I. | Type Commander |

A LITTLE PERSEVERANCE CAN GO A LONG WAY.

## truth and consequences

Continued from page 23

12,000 feet. He was instructed to check inbound over the homer at 5500 feet. But there were no further calls from the TV.

Wreckage of the aircraft was found several days later on the side of a ridge at the 3100 foot level. The accident site was at the approximate position of a correctly executed jet penetration turn but 79 more degrees would have been necessary to have taken up the published inbound heading to the homer. Weather at the crash scene at the time of the accident was zero-zero in dense fog as a cloud layer from about 2000 to 5500 feet obscured the mountain top areas.

The board noted that the pilot was well qualified in model and had made the same penetration and approach two days earlier. The pilot was on course but for some unknown reason was at 3100 feet instead of the prescribed altitude of 5500 feet.

One of the recommendations was for all pilots to again be cautioned about the hazards involved in making instrument weather jet penetrations over mountainous terrain.

Home base of the pilot was a Gulf Coast station where mountains do not present an approach hazard. One of the endorsements to the accident report noted that "pilots familiar with (the penetration in question) have reported experiencing erratic ADF indications while proceeding inbound at 5500 feet to the homer. It is considered possible that if the penetration turn is delayed beyond three nautical miles after passing the radio beacon, the aircraft's position could be such that the mountainous terrain could interrupt the radio signals. It is conceivable that the pilot could interpret the erratic indications as station passage, resulting in a premature letdown."

**SKYLARK**—While on a local VFR test flight in a TV-2 the pilot intentionally flamed out engine to determine the possibility of lowering and locking the landing gear while the engine was only wind-milling. At 22,000 feet and at 160 knots it was determined with the engine turning at 6% RPM that the gear would lower in about 6 seconds. The pilot then attempted an airstart with negative results due to low battery potential. A flameout approach was begun and the emergency hydraulic system energized to insure that the gear was locked. A successful landing was accomplished. An immediate ground check revealed that both batteries were dead.

The foolhardiness of a pilot arbitrarily shutting down a single-engine aircraft under other than emergency conditions has been firmly presented to all pilots of this command.

*Comments and recommendations*—The pilot's actions indicated extremely poor judgment in that:

1. He jeopardized his own safety as well as the safety of others in an area where extensive training operations are conducted.

2. He set a poor example for student aviators by displaying an amateurish approach to the solution of a technical question.

3. He ignored the possibilities of coincident material failures when he shut the engine down.

**WHO'S ON FIRST?**—AN R5D cleared 1000 on top with 40 passengers and a deadhead crew of three for the return flight. DD 175 was signed by one of the return pilots, who did not occupy the controls until things became abnormal. En route buildups were observed, and an altitude of 11,000 was assigned. Light icing was encountered, destination was reported above GCA minimums. Later icing became severe, a requested lower altitude was not approved, and destination was now below minimums.

Aircraft was cleared and reversed course to a suitable alternate. While enroute to the alternate the pilot was advised his destination was again open, and was cleared to the original destination. Local sequence shortly before reporting to GCA was "Est. 500 broken, 900 scattered, vis. 3 miles in light snow, wind ENE 8." A normal GCA was initiated but pilot responses were slow and GCA finally went to a no-gyro run which was waved off. After the waveoff pilot told GCA he was "almost out of gas on one engine."

Next approach was good and the aircraft touched down 1200 feet down the runway which had 3½-4 inches of snow. Pilot attempted to correct skidding with throttles and, with approx. 1000-2000' remaining, full power was applied for a go-around. The starboard main gear struck the edge of a gully and the aircraft became airborne. The gear was cycled with no apparent trouble, but the trailing edge of the wing was observed to be wrinkled for about 4 feet from the root.

At this time the senior pilot of the deadhead crew assumed the right seat and the third approach was waved off when it got dangerously low. The fourth approach touched down hard, nearly three-point, about 20 feet beyond the threshold lights. The starboard wing parted from the fuselage at the root and fire

broke out. The fuselage slowly rolled to the right until inverted and stopped about 1400' down the runway. Crash equipment had been alerted since the wave-off and was on the scene almost instantaneously. All personnel evacuated within 90 seconds; 25 persons received minor cuts and bruises, the remainder were uninjured.

**CLIMBDOWN**—The Air station was VFR with a low scattered to broken layer north and west of the field. Briefing for a group of F9F-6s preparing for takeoff had included a practice controlled VFR climbout on a northerly heading but no climbout instructions had been issued by the tower.

The flight leader and his wingman broke ground and turned to the climbout heading. In about one minute they were at the base of the clouds at about 1200 feet. Checking the wingman's position, the flight leader then concentrated on heading and climbout.

As the section started to enter the clouds a pilot of another section noticed the wingman slowly leaving his former wing position just before disappearing into the layer.

About 10 to 15 seconds later the flight leader popped into bright sunlight and reported on top at 1800 feet. According to the tower operator's statement this was the first indication that the *Cougars* were climbing through the cloud layer without climbout instructions (*location of the field is in a high density area with two major civil fields within a radius of 10 miles*).

After reporting on top the flight leader found his wingman gone and was unable to gain radio contact with him. The remainder of the flight joined up and remained in the area for 30 minutes, attempting to contact the wingman directly and through the tower.

A search and rescue unit located the F9F-6 crashed in shallow water in the vicinity of the spot where the flight went into the cloud layer. The plane hit at an estimated 350 knots in a steep dive. The pilot and seat had remained in the aircraft.

The wingman had a total of 900 hours with 37 jet hours. His F9F-6 time totaled 34 hours but he held no valid instrument card and he had no instrument time in type. He had received 6.7 hours of instrument instruction in the preceding three months in the SNB.

Pilot disorientation and vertigo while under instrument conditions was considered the most probable cause of the accident. Secondary cause was recorded by the board as error by the flight leader for electing to climb through a cloud layer whose actual depth required instrument flight.

It was recommended that all pilots, and flight leaders in particular, be made aware of the inherent dangers involved in entering instrument conditions when members of the flight do not possess valid instrument ratings or minimum instrument flight time requirements in type aircraft.

# Winter Wonderland

If you pile up an airplane you will find that YOU as pilot will have most of that responsibility, whether you accepted it or not. A company dispatcher will clear you when braking is "POOR TO NIL" with the reasoning: "None of the previous flights have had any trouble".

Supervisory Pilots indirectly approve of operations from runways with no braking action, by making light of the danger of operating off icy runways when there is not enough braking action to run up the engines, even one at a time. They do however warn against not properly checking brakes before landing AFTER taking off from such a slippery runway (to prevent taking off with brakes locked and blowing out the tires on a dry runway at destination).

An accident investigator has a peculiar habit of asking embarrassing questions! (Ask anyone who has been "ON THE SPOT"). Why not beat him to the punch by asking YOURSELF the following questions *before* taking off from an icy runway with braking "POOR TO NIL".

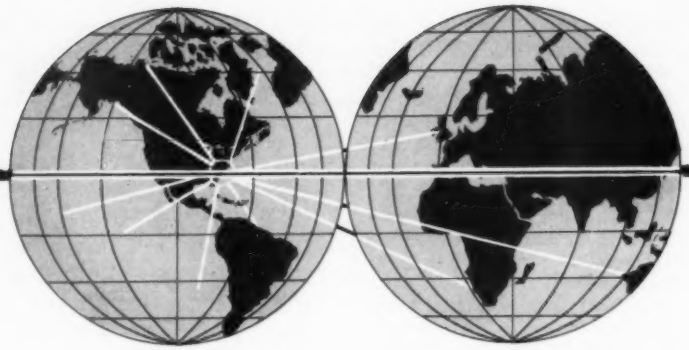
1. If you lost an engine 5 to 15 knots before reaching V1, could you stop the airplane safely *on the runway ? ? ?* 2. Would you have enough directional control and skill to continue straight on the runway through V2, and take off safely? 3. Is it a safe operation?

If your answer to these questions is YES, then fine go ahead ! ! ! But if not, why "put your head in a lion's mouth" ! ! !

An airplane skidding off the runway sideways, knocking a landing gear through a fuel tank, could easily be the fastest and biggest gasoline fire you have ever seen, and POSSIBLY THE LAST ! ! !

ALPA Technical Talk #56-V

# MONITOR



### Keep Away

When an aircraft accident occurs, too many aircraft proceed to the scene of the crash and thus hamper rescue operations and endanger themselves as well as other aircraft. It is recommended all pilots be cautioned to remain clear of the scene of an accident unless he can be of assistance.—*3rd MAW*

### Maintenance Inspections

A staff maintenance team is currently conducting inspections of squadron aircraft. One instance was cited of an aircraft inspection that we deemed unsafe for flight and a four week period of repairs was required to bring the aircraft to acceptable standards. Squadron commanders are enjoined to review their maintenance standards most critically.—*FAir Alameda—NABS 12*

### External Stores

The council recommends that all squadrons post, in a prominent place, for the benefit of maintenance personnel and pilots, a diagram showing the permissible external stores their aircraft may carry. The diagram should also include the maximum unbalanced loads that are authorized.—MAG-*31*.

### Wearing 'Chutes

Many non-flying personnel requesting rides in ferry are unfamiliar with survival equipment. During emergency drills it has been determined that the non-flying personnel cannot put on the parachute harness in ample time to be effective.. Therefore it was recommended that all non-flying personnel carried as passengers in the ferry aircraft be required to wear the parachute harness at all times during flight.—*VR-32*.

### Ignition of Gasoline from Radar

Refueling should not be conducted within 150 feet of energized radar in military aircraft. There is danger of accidental ignition of the gasoline vapors from sparks caused by the microwave transmissions. All pilots, air crewmen and maintenance personnel should have this information brought to their attention.—*Sub-Council, Adak*

**EXCERPTS FROM SOME OF THE NAVY'S SAFETY COUNCILS THROUGHOUT THE WORLD, WHO PROVIDE LOCAL LEADERSHIP AND EMPHASIS TO THE NAVAL AVIATION SAFETY PROGRAM.**

### Filter-Tip Fumbles

Many pilots, probably not you, have been known to sneak off the oxygen mask for a quick drag on a cigarette. This would be a pretty poor time to fumble, and I believe we have all fumbled at least once. Don't take that chance. A couple of hours between those cigarettes is a pretty cheap price for your life.—MAG-*12*.

### Noise Attenuators

The greatest difficulty encountered with the use of ear plugs and noise attenuators by line personnel is to insure that these personnel wear the protective devices. It was recommended that Line Maintenance Supervisors make daily inspections to insure that the devices are being worn by all line personnel.—*Sanford Safety Committee.*

### A "Request" for Violation of Safe Practices

A fatal crash of an F9F was caused by the pilot attempting an aileron roll at an altitude of 150 feet on the request of a ship for photographic purposes! Pilots have a tendency to perform unsafe maneuvers at the request of personnel on the surface, such as in this case. It must be stressed that such requests do not constitute authorization for low level maneuvers. *MAG 13.*

### Decisions

Even after exhaustive PLANNING the pilot must still decide if the flight contemplated is within his own capability considering experience, training and physical condition. It is incumbent upon all aviators in a supervisory position to insure that necessary FLIGHT PLANNING is accomplished.—*1st MAW*

### Required Reading

Did you ever 'spend a day reading safety regulations? If so remember one thing; every one of those instructions was written because somebody got hurt doing that particular thing in the wrong way. Just picture each one of those safety precautions chiseled on a tombstone and you'll get the idea why they're important. "Read 'em and live by them—because if you don't you won't be around long, and we'll be up nights writing another Safety instruction."—*3rd MAW*

# COLD FEET

This article developed from basic material written by CDR David Minard, MC, USN in BuMed "Newsletters."

WITH a thousand and one things each officer had yet to get ready during this week before their deployment, it was typical of the exec, to call on the safety officer for a lecture on cold weather.

The safety officer tried to recall something he'd swiped from APPROACH, a tech rep or some other informative source.

He had for some time past been compiling a safety file of sorts and now began to run through it with hope of finding some appropriate subject matter.

Keeping in mind their coming operations which would be devoid of palm trees, sunshine and warm sands, he leafed through a folder labeled "winter," and finding it much like a Mother Hubbard, he began to recall all the instances he could remember related to cold weather . . .

HE AND a classmate had had to RON at Minneapolis a couple years back. He related how a large low pressure area had blanketed everything north of Dixon and a little bit of Mason with snow. There had been a fairly steady wind all day with several severe gusts that had brought the temperature down considerably, but not to an uncomfortable or complainable point.

After they had checked in and made sure the *Beech* was secured for the night, they ambled into the BOQ and beelined for the snack bar before closing time.

As they entered through the swinging door with a swish of cold fresh air, a voice from the dark corner rang out.

"Shut those d____d doors! . . ."

The safety officer had turned around to see huddled in the leather-covered booth, Bob Chilblaine, alternately perspiring and shivering, with a bluish face that almost blended with the blue design on the Dixie cup he had clamped between his hands.

He had known Bob since carqual days, 'though they'd never been in a squadron together. He carted his BLT and coffee over to Bob's table to listen to his recent bold-in-the-cold-but-sufferlater story.

Bob related how he and a buddy had flown up to the duck country in a friend's *Piper Cub* which let in more cold air than a new air-conditioner. They had arrived there early in the a.m. to allow them a full day in the blind. Everything had gone fine until around noon. Then an overcast closed in and dropped a half-inch of rain into the boat.

When the temperature had dropped to about 50° F. both of them began to feel the chill creeping up from their wet feet. The cold soaked clothes and wet feet only antagonized them and heightened the challenge of the duck hunt.

It was well after four o'clock before they finally gave up and returned to the landing. Everything was wet and cold, the *Cub* creaked and groaned as they taxiied along the slippery grass runway and towards home.

TWO weeks had elapsed since their outing and both Bob and his buddy wound up in the dispensary with a diagnosed second-degree cold injury.

"Cold injury!"

The safety officer had never heard the term used before, so Bob, recently briefed by the medical officer, went on to explain.

"Cold injuries," he said, "are considered much like burns, classifying them as a first, second or third degree injury, depending on the amount of exposure and damage to tissues and nerves. With a slight injury you might notice that your hands or feet are pale, or bluish and mottled, cold and numb, and puffy before they return to normal."

"A more severe injury or prolonged exposure will result in blisters or blackened areas, just like a severe exposure to heat. For weeks after a severe cold injury you are apt to find yourself plagued with excessive sweating, a blueness, prickly sensations, or sensitivity to cold.

"These symptoms, persistent, together with muscle weakness and signs of lasting nerve injury are more common in non-freezing cold injuries than in frostbite."

It was obvious that Bob had gone into the whys and wherefores of cold injuries and to get further into the subject, the safety officer got another round of coffee. This kinda dope should be worth something to the pilot who is sometimes exposed to cold in cockpits at altitude and 'most anywhere in winter, he prodded his companion to say more.

Continued next page

# COLD FEET

Continued

"You could class a cold injury," Bob continued, "as either *mild cold feet, acute cold feet,* or the more serious injuries such as *mild* or *acute body chilling.* One of the main reasons for damage to the tissues in cold injuries is the lack of oxygen which is carried by the blood and as the feet and hands or parts of the body become chilled, the blood thickens and slows down. Of course, a pilot wearing tight clothing adds to this constriction."

"Any wetness such as water that slops around in the bottom of a raft, or like in the boat on the duck hunt, increases the hazard as it accelerates heat loss as does wind. This added danger from moisture has led to the specific name of 'immersion foot' for a non-freezing cold injury when the hands or feet are exposed to cold sea water such as in the raft under survival conditions."

THE medical officer at the dispensary had told Bob that all aviators have "poor circulation" under certain conditions such as G-forces and high altitude where the lack of normal pressure may result in disturbing circulation. And unless controlled by a well-planned system of rotation, mental and physical fatigue is another factor associated with increased cold injuries.

He stated that he could check on the clothing supply, provide training and treatment when necessary, but that cold injury prevention was mainly up to the pilot himself. Applying common sense in using sufficient and proper hand, head and foot gear, not too tight, and changing often enough to keep dry, is essential. Also circulation can be improved by wiggling your fingers and toes, stamping your feet or clapping your hands together.

The medical officer had told Bob that treatment of non-freezing cold injuries of an extremity should be (1) a *slow* rewarming and (2) protect the area from weight bearing or additional injury.

This of course was for the *mild cold feet* type of injury, but the *acute cold feet* injury was another story. Being considerably more dangerous, as is a freezing injury or frostbite, a serious error can be made. The first-aid or professional treatment consists of a *rapid* rewarming of the part by immersion in water at 95° to 105° F. If warm water is not available, the hand or foot can be placed against warm skin. Both of these types of injuries are common to the pilot who ditches in cold sea water.

OCCASIONALLY a pilot may be downed on land and faced with the possibility of a long exposure which calls for varied treatment. In the case of *mild body chilling* rewarming probably should be slow.

In the event of *acute body chilling,* immediate rapid rewarming is lifesaving. A number of people rescued alive and conscious have died from slow rewarming.

This rapid rewarming sure differed from what Bob ever heard, but then after the Doc had explained the reasons behind it, it became quite clear.

If the environment is too cold for the body, it shuts off the flow of blood to the body surface, and the surface tissues become cold or frozen to the extent that often the hands or feet are lost. In a sense nature sacrifices the hands and feet in order to retain warmth in the center core of the body to protect its vital organs.

So when rescued and brought into a warm environment blood again flows to the surface. If it goes through chilled tissues, it becomes chilled and then returns to the body's core and may in turn chill the vital organs enough to cause death . . . *after rescue.*

This is why it is vitally important to rapidly rewarm the surface tissues, preferably by immersion in a hot bath of 110° to 120° F., or a steaming shower if the bath is not available.

If a minor injury to a hand or foot is combined with the *acute chilling,* as often happens, exclude the injured part from the hot bath if possible.

Bob had learned that chilling as well as freezing can be serious, and that even the chilling of an extremity can have its lasting after-effects.

All exposed personnel should follow the precautions advised by the medical officer to wear proper clothing, immersion suits, and remember the first aid rule: *Mild cold injury* calls for slow rewarming, while frozen *extremities* or *acute body chilling* requires rapid rewarming. Prevention remains the only satisfactory method to avoid cold injury.

• • •

# WHEELS-UP SAVES

TO ALL men who watch for wheels, the Naval Aviation Safety Center expresses a sincere WELL DONE.

The payoff is reflected in the following box score: Major wheels-up landing accidents (pilot-caused):

| | | |
|---|---|---|
| 1956 | 1 Jan through 22 Sep | 49 |
| 1957 | 1 Jan through 22 Sep | 24 |

| WHEEL WATCH | STATION | AIRCRAFT | DATE |
|---|---|---|---|
| SGT B. C. BARR | NAS Anacostia | AD-5 | 3 July |
| ‡CURRY, N. V., AB2 | NAAS Cabaniss Field | AD-4 | 9 July |
| NICKELL, T. A., AN | | | |
| 1st LT L. FARRELL<br>Cpl W. R. SILVA | VMF-234<br>MABS-27, MCAS Cherry Point | USAF T-33 | 22 July |
| FRAZIER, J. A., AC1 | NAS Moffett Field | F9F-6 | 14 August |
| PFC A. G. HIGLEY | MCAS Quantico | T-34B | 13 August |
| KLOCHAK, G. N., AN | NAS Patuxent River | P2V | 17 August |
| Pvt J. KNAPIK | MCAS Miami | FJ-3 | 25 July |
| LESSMAN, G. E., AC1<br>HALL, F. F., AN<br>THOMPSON, J. L., AN | NAS Quonset Point | S2F | 31 July |
| MAYBERRY, J. L., AC3 | NAAS Cabaniss Field | AD-4 | 9 August |
| McCARTY, W. B., AC1 | NAS Moffett Field | A4D-1 | 5 August |
| MAJ M. B. McELHINEY<br>SGT F. E. CONLON | VMF-113<br>SOES, MCAS Cherry Point | F9F-6 | 1 August |
| MEADOR, L. A., AC2 | NAS Norfolk | USAF T-33 | 10 July |
| §NATH, J. T., AC1 | NAAS Cabaniss Field | T-28 | 22 August |
| PRINCE, R. L., AC3<br>GARREN, W. F., AC2 | NAS Chincoteague | USAF F-86 | 17 July |
| PATTON, W. T., AN | VU-4 | | |
| RASH, J. W., ADR-3 | VAAW-35 | AD-6 | 23 July |
| *ROBERTS, R., Jr., AA | NAAS Chase Field | TV-2 | 19 July |
| SCHULTZ, W. E., AD-2 | NAAS Cabaniss Field | AD-3 | 18 July |
| SHAW, C. E., AC3 | MAS Anacostia | AD-5 | 3 July |
| *SGT J. R. SPLAWN | SOES, MCAS Cherry Point | FJ-3 | 8 July |
| PFC C. W. WALLAR<br>PFC A. E. BELGRAVE | MCAS Miami | F2H-2 | 21 July |
| *PFC C. W. WALLAR<br>PFC A. E. BELGRAVE | MCAS Miami | F2H-2 | 21 July |
| †PFC C. W. WALLAR | MCAS Miami | F9F-6 | 3 August |
| ‡PFC C. W. WALLAR<br>LT H. WARDENGA | MCAS Miami<br>VF(J)-801 | F9F-6 | 4 August |
| WHITAKER, R. D., AA | NAS Moffett Field | AD | 13 August |
| WOOD, G. K., ATAN | VF-114 | AD | 7 August |
| YOUNG, C. H., AE3<br>JONES, R. E., AC2 | VF-112<br>NAS Miramar | F9F-6 | 4 August |
| *C. H. YOUNG, AE3 | VF-112 | F9F | 17 August |

* One previous save
† Two previous saves
‡ Three previous saves (in the case of CURRY, all were at night)
§ Seven previous saves

* * * * * * * * * * * * *

One of the letters submitting a name in the above listing is of interest both in the occurrence and preparation;

*". . . At NAAS El Centro at 2100 on 23 July, Rash had the wheels watch and caught an AD-6 just about in his flareout with gear neatly tucked in the full UP position. . . . Our own AAR 4-57 concerns a wheels-up landing at El Centro, so we are highly gratified to think that we have profited by past mistakes. I (as Safety Officer) interview every man from this squadron who may be called upon to stand a wheels watch. We will assign only those whose GCT scores are 50 or higher. For a "save," we award a 48-hour liberty on a duty weeknd.*

*The O-in-C of our detachment at El Centro at the time of this save gave our hero RASH a pretty long briefing on the importance of his duties as a wheels down watch stander immediately before he went on watch.*

*I must admit that reporting Rash's save is indeed less expensive and far simpler than an AAR. /signed/ Joe Gallagher, VAAW 35*

# Notes from your flight surgeon

A3D practice bailout chute being fitted by its designer, Flight Surgeon Backer, and builder, Chief Structural Mechanic Don Walton.

### A3D BAILOUT PRACTICE

HOW to conduct A3D bailout drills without injury was the problem faced by Flight Surgeon Lt. Gordon L. Backer of Headquarters, Heavy Attack Wing One. The A3D's escape chute is so situated that bailout drills were resulting in torn parachutes, lacerations, dislocated backs, and even one broken leg.

Dr. Backer went back to childhood days for his solution to the problem, and came up with a Heavy Attack version of the playground slide which has proven to be remarkably effective.

Using personnel of VAH-5, also based at NAS Sanford, as his evaluation subjects, Dr. Backer found that a tactical three-man crew could get out in an average time of 11 seconds—the best time was 9 seconds. Recognizing the possibility of low-altitude bailout and subsequent time lost in locating the elusive D-ring, Heavy Attack crews are instructed to exit with arms crossed, right hand grasping the ring.

. . proper method of bailout includes crossed arms, right hand on D-ring

### HIGH BOOTS

A RECENT AAR which involved ejection at high altitude from an A4D contained a recommendation that APPROACH discuss the physiological and aerodynamic problems associated with high-altitude, high-speed ejection. As more material on the subject becomes available it will be published; for the present, readers are referred to "High Altitude Ejection" in the February 1956 issue of APPROACH, "Mach Knock" (June '56), as well as others listed in APPROACH annual indexes, July 1956 and July 1957 issues.

### TV PILOTS' ESCAPE

INVESTIGATION of a recent fatal TV accident disclosed that when the canopy failed to jettison the aviator neglected to use the manual control for release of the canopy, presumably because of a faulty knowledge of the escape systems in the different models of the TV-2 aircraft.

Agreed!—there are too many variations of the escape systems involved in the different models, and the design of the escape systems is too complicated.

Agreed!—the escape system should be simplified and standardized to a one-point system.

But—in view of the numerous design variations in models now in flight, a review of the escape system from the pilot's viewpoint was presented to your safety officer via "Crossfeed," No. 17 (15 July 1957). In an effort to avoid future difficulties it suggests more frequent personal and squadron review of these complicated systems.

### RED IS BETTER THAN WHITE

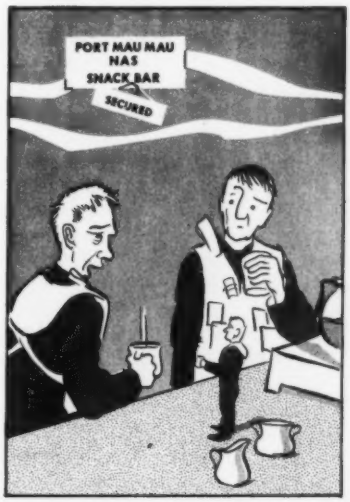
IT HAS been observed that many crews are using the full white lights in the cockpit to make their pre-takeoff checks. This tends to retard their dark accommodation which is so necessary over cities in high density traffic areas. The use of full red lights and as little white lights as practicable will materially aid in observing traffic soon after takeoff.—*ALPA—Technical Talk for Pilots 57-3*

### OWES LIFE TO KNIFE

SHORTLY after takeoff, about a quarter mile off the carrier's starboard bow, the HO4S-3 lost power at 200 feet and went into the water nose-high. It rolled to the right and nosed down, almost in an inverted position. Three of the four occupants, none injured, left the cockpit.

But the copilot was standing in a window, caught by several straps. Still submerged, he cut three straps, one of which was the shoulder harness, another believed to be the waist belt on the life jacket, then popped to the surface. When he inflated the CO cartridges he noticed the mae west tended to ride up over his head because of the severed waist strap, but he was rescued without incident by helicopter.

"I had almost given up when I thought of the knife on my life jacket."




Tell Ed about the day you buzzed that witch doctor's hut.

### NO KNOW, NO FIX

THE FIRST firing run on the banner was slightly acute and on recovering off the banner the aircraft shuddered slightly. At this point the oxygen regulator, which was on NORMAL, jammed full OPEN. There was constant pressure in the mask and exhalation was almost impossible. The pilot turned the regulator OFF and went back to the perch. On turning it ON again it was o.k.

On the next run, just as he commenced firing, the regulator again jammed full OPEN. The banner was right in front of him and he hit it with the right wing on recovery.

He was able to land the plane, and ground-checked the regulator and mask which seemed normal in all respects. "I knew better than to continue making runs but let overconfidence get the better of me. This is the *third time* I have experienced the regulator jamming full open when pulling G, two times on tactics hops, and this time."

The third time! **And it was not reported before!**

*Until this report the cognizant bureau with authority to initiate a fix was unaware of this condition.*

*The malfunction has since been corrected. Though you may think your gripes are ignored, that isn't so. It's just that the mills grind slowly.*

*And they don't grind at all without your reports. So, Puh-lease tell somebody!—Ed.*

a realistic appraisal of

# O-Ring Packing Leakage

*by Ralph E. Middleton, Lockheed hydraulics and [illegible] design specialist*

*Courtesy "Lockheed Service Digest"*

O-RINGS which provide external seals for moving shafts in hydraulic units are, by their very nature, almost always subject to varying degrees of leakage. Years ago, many people said that hydraulics on aircraft were impractical because no one would ever find a seal that would not leak. Actually, designs which require absolute fluid-tightness for successful operation have never been completely feasible, and probably never will be.

Years of experience with hundreds of thousands of hydraulic units have proved that O-rings suit their purpose better than any other type of seal known today. O-rings are practical—particularly if leakage in judged from a practical viewpoint.

The main question which we wish to answer here is, "When is leakage serious enough that a hydraulic unit should be replaced?" We believe that a realistic answer will result in a substantial reduction in the number of unnecessary removals experienced at some activities.

## DEVELOPMENT OF SEALS

**Rubber Cups.** In the earlier aircraft hydraulic systems, fluid was retained within working components by means of rubber cups somewhat like those used in automobile hydraulic brake systems. These cups, when carefully made and used with smooth metal surfaces, produced fluid-tight seals—for a while. However, they had several very undesirable weaknesses. In order to seal against the metal surface, the lips of the cup could not be stiffened sufficiently to prevent their folding back on themselves or tearing. Also, the proportionately large amount of rubber in the cup was such that any swelling caused the heel of the cup to expand and contact the sealing surface. This deformed the lips of the cup and they would move away from the sealing surface.

These failings would eventually result in a complete loss of fluid from the hydraulic system, since the rate of flow past the damaged seal was very great.

**Chevron Seals.** In an endeavor to correct some of the disadvantages of the rubber cups, the V-shaped packing ring or chevron seal was adapted for aircraft use from its usage in heavier industrial packing applications. The chevron seals were usually installed in a stack consisting of two or more seals with metal adapters at each end of the stack. These seals had the advantage of greater operating strength and, as they were installed in multiples, a flaw in one ring would not necessarily result in a leaky gland.

However, chevron seals had a high and variable rate of friction. Also, these seals were bulky and

difficult to adapt to a valve application without resulting in a very cumbersome design.

**O-Rings.** The O-ring was a great improvement over both the cup and the chevron seal. Because of its simplicity, it literally revolutionized the design of hydraulic components. It could be stretched or squeezed into grooves in ways not possible with any other seal. This allowed a reduction in size and weight of hydraulic components and permitted the hydraulic system to do a greater variety of jobs.

The O-ring is also a stronger seal. There are no thin lips or protrusions to break off or deform. A greater amount of seal area contacts the metal surface so there is less tendency for the rubber to flow, or extrude, through the crack between seal and sealing surface. This strength of the O-ring provides increased protection from a sudden and complete loss of system fluid.

**Some Faults Too.** As with most things, there are also some faults with the O-ring. Being round, the O-ring can roll slightly in operation. If a portion of the ring rolls too far in the groove it twists a cross section of the ring and leads to what is known as spiraling. This can permanently deform the ring and may result in its cracking or parting completely.

Since the O-ring is a round section, it must bear against the sealing surface with sufficient force to deflect into the minute grooves of the machined surface and stop leaks. This makes the degree of seal achieved sensitive to slight imperfections in the O-ring and the effects of certain types of foreign particles such as threads, hairs, or fibers lying across the sealing face. These faults can be minimized by selecting and installing the O-ring carefully as described later.

**O-Ring Squeeze.** With practically all types of seals, the pressure, or squeeze, necessary to produce a good seal, even at low hydraulic pressures, is produced by having an interference fit between the seal and the metal surface. For the O-ring to be effective, this fit is critical and is established by the diameter of the O-ring as shown in Figure 1. Not enough squeeze will, of course, result in an ineffective seal. However, there is a limit to the amount of squeeze that can be employed. Too much squeeze means: increased difficulty of installation; more friction at low pressure, and increased deformation of the ring in its groove. Also the undesirable tendency of the rubber to adhere or bond to the metal surface increases. The military specification MIL-P-5514A lists the amounts of squeeze which will produce the best results in most installations.

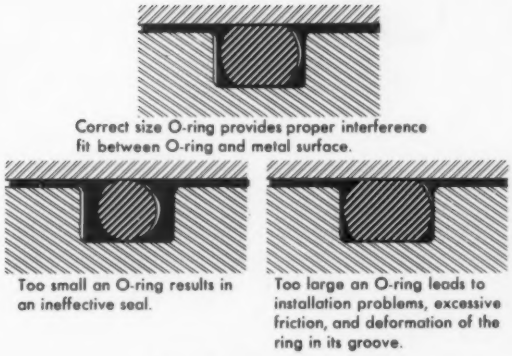

Correct size O-ring provides proper interference fit between O-ring and metal surface.
Too small an O-ring results in an ineffective seal.
Too large an O-ring leads to installation problems, excessive friction, and deformation of the ring in its groove.

Figure 1 O-Ring Squeeeze

## BACK-UP RINGS

As hydraulic system pressures were stepped up from 800 to 1000 psi, to 1500 psi, and then to 3000 psi, the load on the O-ring seal increased considerably. The tendency for the O-ring to extrude increased and became critical. Also, actuator shafts which moved in and out many times a minute placed a heavy burden on the O-ring. These circumstances necessitated an extra ring in the groove to support, or back-up, the O-ring (see Figure 2).

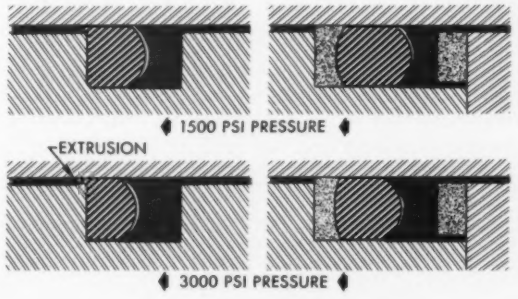



Figure 2 O-ring Under Pressure

Leather was the first material used for back-up rings. It was stiff enough to resist extrusion but pliable enough to flow into place and help the seal. However, leather is sometimes too hard, sometimes too soft. It absorbs moisture and contains acid and salt, all of which corrode metal. It often shreds and the fibers can get into the system and under O-rings.

Continued next page

# O-rings

Continued

Teflon, a synthetic plastic material, has recently been found to be a more satisfactory back-up ring material than leather. It has low friction, is somewhat pliable and is chemically inert. One disadvantage with this material is that it is not flexible enough to be stretched or deformed into place in a groove and so it must be split for most installations. The split, or scarfed, ends can sometimes cut the O-ring. This difficulty, however, is gradually being resolved by continued research.

## EVALUATING LEAKS AROUND O-RINGS

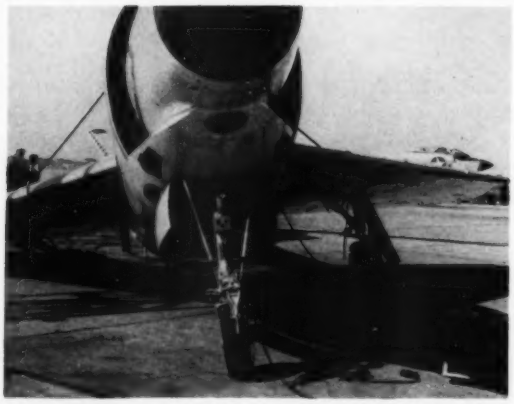
It can be seen from the foregoing discussions that leaks, large and small, and caused by a variety of things, can accompany any seal. The successful and practical approach to the problem is this: Before deciding to remove and replace a hydraulic component, evaluate the effect of a leak in any unit and in any system to determine what amount of leakage can be tolerated and what amount might be a hazard to the safe and effective operation of the aircraft.

**Types of O-ring Leakage.** In the first place, we should differentiate between failures that allow a complete loss of fluid and faults that usually result only in slow leaks from a unit.

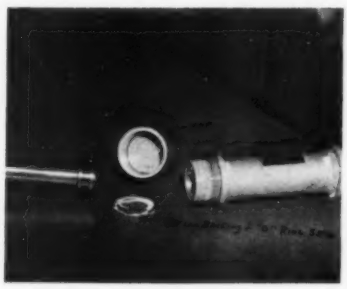
Except for failures of the spiraling variety and cases where static rings blow out or pieces of moving seals are actually torn out due to excessive clearance, O-rings normally do not fail so as to cause complete system failure.

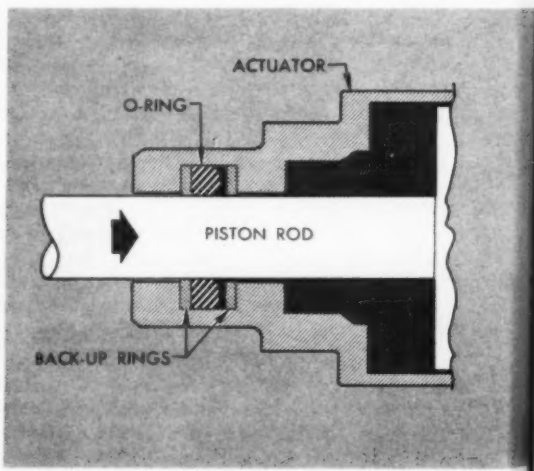
However, as previously stated, O-rings may be expected to have leaks of the seep or drip variety and there are several reasons for this. As the pressure builds up or decreases in a unit, the O-ring moves in its groove. As it moves, it also rolls somewhat because of its shape. This creates a pumping action that permits a small quantity of fluid to get by on each cycle of pressure change. This also happens when a shaft or piston is moved in a bore. Pumping even occurs to some degree with a static seal. Static seals are so called because the parts presumably do not move. But there is always some deflection or slight motion in the seal parts.

Ambient air temperatures affect the sealing quality of the O-ring. In cold weather the seal contracts and provides less absolute sealing in the static condition. In the same manner temperature cycling can also induce a higher leak rate. This is usually the case when an aircraft is moved to and



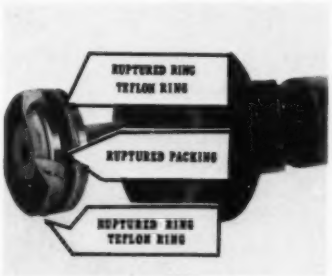
Right landing gear on F3H collapsed, above, when O-ring, below, failed. End-cap of cylinder was 2 full turns from bottoming. Over-travel of piston exposed seals to cylinder end for damage.

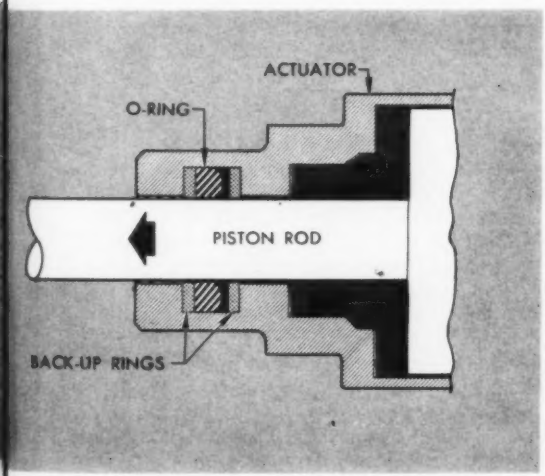





O-ring pumping action—rolling of O-ring squeezes or p

Cause and effect—Ruptured Teflon back-up ring, below, caused loss of hydraulic pressure in the AJ above, preventing the left main landing gear from locking DOWN.




minute quantity of fluid at each cycle of pressure change.

from a heated hangar during cold weather.

Since the O-ring requires a relatively greater bearing pressure to create a seal than do the cup or chevron types, the O-ring is sensitive to slight imperfections in its own surface or in the metal surfaces as previously mentioned. A rough bore, rod, or O-ring groove will, of course, be more apt to cause leakage than a smooth one. However, the apparent smoothness of a surface can be deceptive, especially after continued wear has created wear marks. It is not wise to assume arbitrarily that the surface finish is too rough from appearance alone. A profilometer reading, or at least a comparison with a finish sample of known roughness is the only sure method.

O-ring manufacturers have made great progress in improving the smoothness and accuracy of their rings, but it is inherently impossible to produce rings having absolutely no imperfections. It remains then, a matter of judgment as to when a defect in a newly manufactured O-ring is cause for rejection and when it can be accepted. Work is now being done on a photographic method of evaluating O-ring defects. This will present enlarged views of the various types of defects so they can be classified as to acceptability.

It should be kept in mind that the characteristics just discussed generally produce the seep or drip type of leak. Progressive or erosive wear of the O-ring should not be assumed as the cause of leakage unless a careful check as described later in the article proves such to be the case.

**Interpreting the Specifications.** The net result of the various shortcomings we have described is that very often we find a seal leaking slightly or passing fluid owing to its pumping action. Internal seals do this also but because they are hidden it is not obvious and no one ever detects it unless it impairs the unit's function. The difficulty lies with the external seals which functional tests specifications usually say, "shall have no external leakage." Various attempts have been made over the years to improve the wording of the specifications to express the intent that a slight amount of fluid escaping past a seal normally has no real significance. The latest wording that is being incorporated in the military hylraulic systems specification says, "There shall be no measurable external leakage."

Continued next page

# O-rings

Continued

This in intended to mean that a light stain or wetting which does not actually form a measurable drop is acceptable.

### O-Ring Packing Leakage

When it comes to moving shafts which work in and out of a stuffing box, or gland seal, as it is sometimes called, the acceptable-leakage problem is even more acute. MIL-C-5503, the military specification for actuating cylinders, has always recognized this by specifying an allowable leakage rate past a moving seal of one drop per 25 cycles of operation. Unfortunately, this arbitrary limitation does not take into account such variables as shaft diameter, stroke, or rate of cycling. These all have an effect on the rate of leakage. Also, the size of a drop varies with the temperature and the shape of the part on which the drop forms. A drop of MIL-O-5606 fluid is normally considered to be 1/20 of a cubic centimeter. Since there are 16.39 cubic centimeters per cubic inch, this means 326 drops per cubic inch, or approximately 75,000 drops per gallon. Obviously, it would take a tremendous number of leaks of the drop variety to have any appreciable effect on the fluid level in the reservoir of the average system.

The specification also fails to take into account the variations in the mode of operation, particularly the operation of power control or boost actuators. In these units the piston rod may move in and out through the gland several times per second. If we assume an average rate of movement of one cycle per second, this is 3600 cycles per hour. At the rate of one drop per 25 cycles, this amounts to 144 drops per hour, or approximately 7.2 cubic centimeters per hour. This would collect a large pool of fluid in each flight but would be within the allowable leakage rate specified by MIL-C-5503. It is obvious that such an amount is more than the average actuator actually leaks, but it emphasizes the necessity for greatly revising our thinking as to allowable leakage. Otherwise we must abandon the use of the O-ring and go to other, more cumbersome type of seals.

**Evaluating Leakage.** Here is a practical approach to deciding whether a hydraulic unit should be replaced and some suggestions for realizing better service life from O-rings.

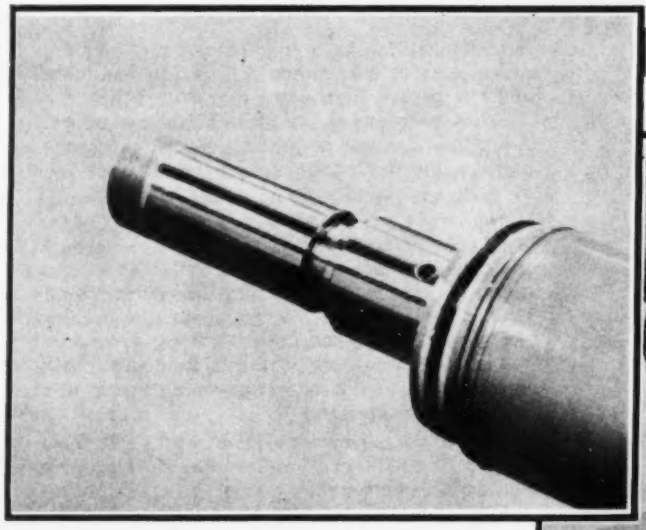
Units such as landing gear, flap drive, etc., that operate only a few times during flight should be considered satisfactory if, upon inspection after flight, only a few drops of fluid have collected. Any large increase in the leakage rate from one flight to the next should be viewed with suspicion, however.

The above units should be allowed some leakage while the airplane is parked, say a few drops overnight. Here again a large increase in leakage over a period of time would be the signal to remove the unit and check the seals.

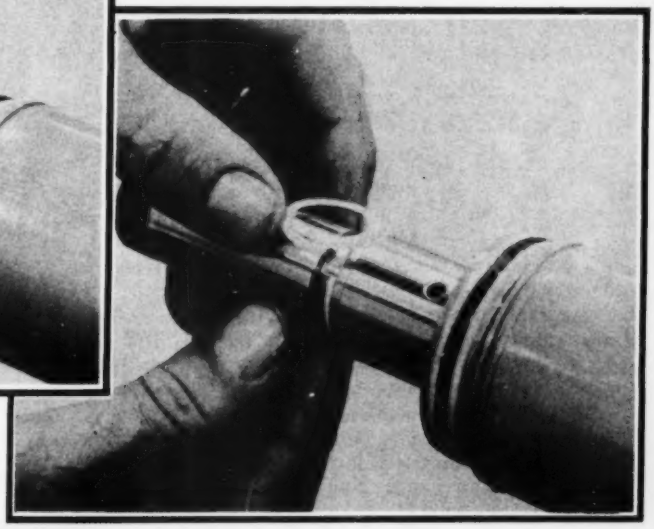
**Power Control Actuators.** For power control actuators, the present specification is not actually a good criterion for allowable leakage. In our own laboratory work at Lockheed we have revised the procedure of measuring drops per cycle and are measuring drops per minute, since operation is more or less continuous. Our present testing procedure is to continue the tests until leakage reaches five drops per minute from a rod seal. At this rate, the amount of fluid that would collect in an eight-hour flight would be approximately 120 cubic centimeters. While this quantity could result in a considerable wetting of surfaces exposed to the leakage, it is not particularly detrimental to the operation of the hydraulic system or the airplane. It should be borne in mind however, that excessive fluid collecting in an area where ignition could occur is a hazard which must be avoided. If such a hazard does not exist, it is certainly preferable to wipe up the excess fluid and to check the reservoir level occasionally than to remove and replace power control actuators.

More on next page

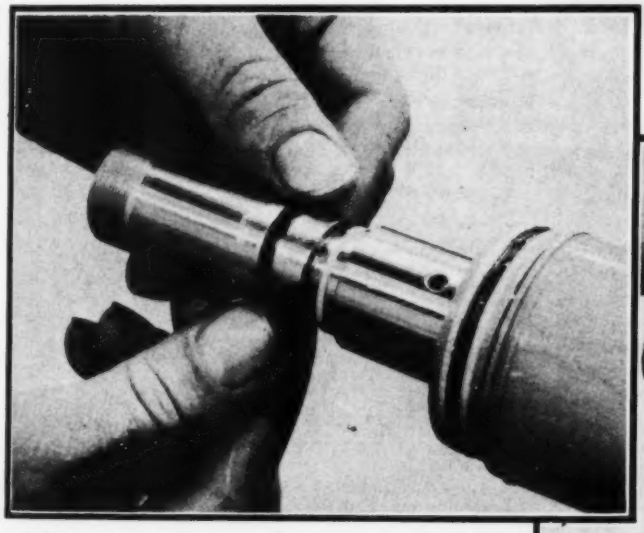
# INSTALLING O-RINGS...



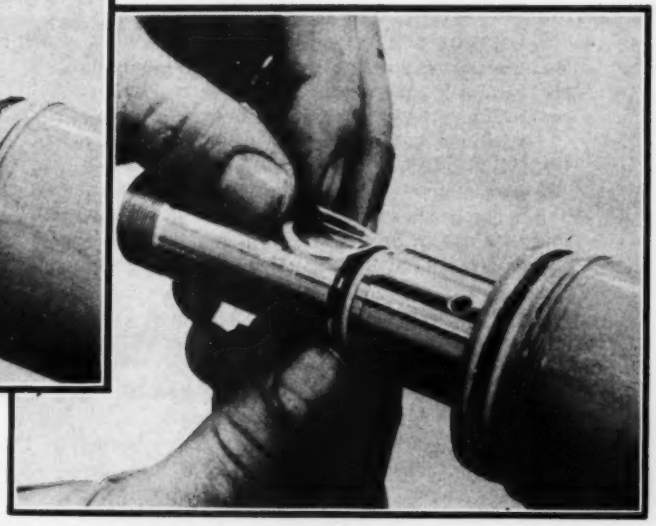
**1** Make sure that the groove is smooth and free of foreign matter. Lightly coat the groove and O-ring with petrolatum or system fluid.



**2** Roll first back-up ring into groove.



**3** Gently roll O-ring over piston rod end and slide into groove. Check mold flash to ensure that ring is not twisted.



**4** Install the second back-up ring. (See instructions for installing back-up rings on the following pages).

# O-rings

Continued

## MAINTENANCE

*Preventive maintenance pays big dividends where O-ring seal is concerned.*

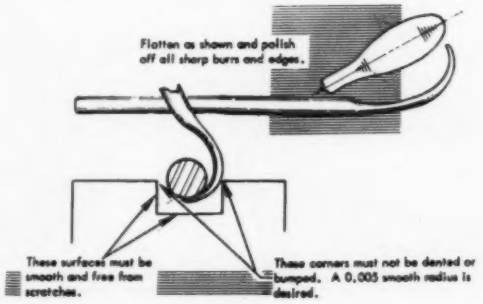
**Lubrication.** Every effort should be made to clean and lubricate piston rods and moisten the felt wipers periodically with MIL-L-7870 general purpose low temperature lubricating oil as called out in the maintenance manuals. The intervals between lubrication should be shortened in severe operating conditions. This procedure will undoubtedly aid in cutting down leakage and will reduce the number of seal failures.

**Installation.** Proper installation of replacement seals is vital. Volumes could be written on this phase of O-ring seals, but if the following main points are observed the O-ring will do its job.

*The following items are excerpts from both the "Lockheed Service Digest" and "The North American Aviation Service News."—Ed.*

- Be sure that O-ring seals are not replaced while the hydraulic unit remains installed on the airplane. These units should be removed and sent to shops or depots for rework where the proper protection, tools, and test equipment are available.
- Don't ignore the critical composition of the part and attempt to stretch and roll it as a rubber band. O-rings must be installed with perfection.
- Use only the specified O-ring. The part number is identified in the applicable Illustrated Parts Breakdown handbook. Never use a substitute O-ring without authorization.
- Do not re-use O-rings. Destroy the used O-ring so that it will not be accidentally re-used.
- All O-rings must be kept clean and dry before installation. The parts are packaged individually in envelopes. Each envelope is stamped with a cure date. Packings should not be removed from the envelope until the time of installation. Packings older than 24 months should not be used.
- Before installing an O-ring, inspect it closely for nicks, cuts or abrasions. Check the assembly and the groove in the assembly for which the packing is intended for smooth, clean surface. A slight roughness or particle of grit can cause damage and the loss of sealing properties.
- To facilitate the installation, immerse the O-ring in the type of fluid that will be used in the system. Some O-rings such as those used in various fuel system components have critical soak time periods. Always check the applicable official handbook for special requirements. Before installing the part, clean the receiving groove on the assembly with the servicing fluid. The fluid will serve as a lubricant to prevent sticking and tearing of the packing.
- Make the O-ring installation carefully. If tools are used, make certain that they do not have sharp edges or rough surfaces. When installing the O-ring over the threads on the assembly, watch that the threads do not nick the O-ring. Some installations can be more easily made by fabricating a brass or steel shim to cover the threads. Avoid twisting of the O-ring during installation. Keep the mold flash line of the O-ring in one place for a reference against twisting. When the O-ring has been seated in the groove, visuallly check its positioning before proceeding with the reassembly of the component.
- If using O-ring removal tools made of metal, exercise care that the groove of the assembly is not marred or scratched.

"O" RING REMOVAL TOOL


Flatten as shown and polish off all sharp burrs and edges.
These surfaces must be smooth and free from scratches.
These corners must not be dented or bumped. A 0.005 smooth radius is desired.

- O-rings should be stored and handled so that the oldest items are used first. They should be stored in a cool, dark and dry area, protec ed from excessive heat and exposure to strong air currents, dampness and dirt. They should be stored away from electric motors and other equipment giving off heat and ozone. ●

WHEN, *in the course of human events,* it becomes possible to install an aircraft part incorrectly, someone will install it that way. —**BENJ. MURPHY**

The pilot of a TV-2 experienced a complete electrical failure. He executed a simulated flameout approach and normal landing was made with no further difficulty.

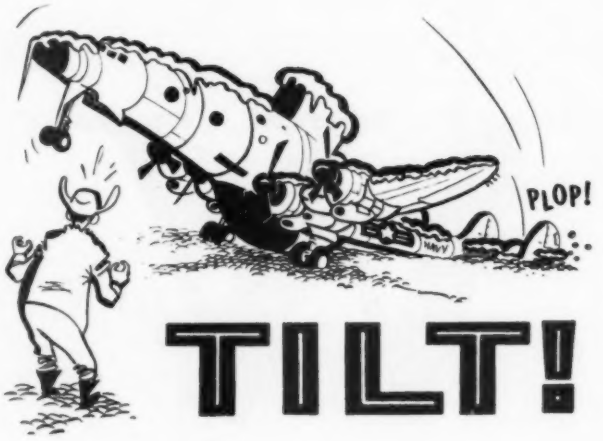
Cause of the failure was the improper installation of the generator.

A Westinghouse (WX-A28A-8584-1) generator was replaced with a Jack & Heintz (JN-6300-4 Borge-20M 75 B1) by the night check-crew the evening prior to the incident. The generator field lead was attached to the "B" position instead of the proper "A" position. The location of the "A" and "B" position are reversed with respect to the Westinghouse and Jack & Heintz generators. Insufficient light precluded visual sighting of the small "A" and "B" identification marks.

*This is an excellent example of Murphy's Law together with the saying that "Haste makes waste." The mechanic stated he did not thoroughly check his work to insure that the lead was secured to the proper position because he had been assigned another job that also required his attention.—NAAS Chase Field, Texas.*

# FROM THE GROUND UP

SELECTED FORCED LANDINGS, INCIDENTS, GROUND ACCIDENTS, NOTES AND COMMENTS ON AIRCRAFT MAINTENANCE.




## TILT!

We are forwarding this fliga
cause our headaches are much bigga
and besides the rule book says we've got to do it
our connie's tail is broken
and get this, we're not joken—
her hull has an antenna poking through it

so I take in hand my pen
thirty-seven fifty, ten
item thirteen says to narrate the occurrence
she was standing in the snow
when her triple tail bowed low
and we can't find if she's covered by insurance

the snow had fallen heavy
on highway, road and levee
our connie was degassed and standing free
twelve full hours down it drifted
then to rain it turned which shifted
her cg aft of 42 mac

down her tail went with a crunch
while the watchman, eating lunch,
said "holy gee, she's really rarin' to go"
with our slipstick we computed
the thing that made her dood it
was approx two tons of wet and heavy snow

our recommendation sirs
in which our boss concurs
is keep the big thing gassed when snow is forecast
though I wish our base at times
was in balmy, sunny climes
where the runways aren't three feet below the o'ercast!

**HYDRAULIC LEAKS**—Hydraulic fluid leakage has long been a subject of much conjecture and speculation. To begin with, there should be no external fluid leakage at any B-nut or fittings. However, leaks do occur very often in the field and sometimes at the factory on newly manufactured airplanes.

Hydraulic fluid may run into cavities, threads, grooves, . . . while components are being tested and flushed and lines and fittings are being connected and disconnected. Over a period of time, this fluid may seep out in sufficient quantity to be visible. Any visible fluid should be wiped away and any additional leakage should actually be measured and recorded. The fluid must leak a measurable amount, i.e. one drop, and must continue to leak at regular intervals to be cause for rejection of the component. *A trace of fluid on the surface is not considered measurable.—NAA Operation and Service News*

**ACCIDENT ENGINE PARTS SHOULD NOT BE CANNIBALIZED** — We hear that at some activities, personnel are indulging in the unhealthy practice of cannibalizing parts from engines involved in an accident.

We'd be the last to deny that cannibals no longer exist, even in the human race. However, some rather pertinent facts about their culinary code stand out that can be compared to the practice of using parts from accident engines. For instance—

No cannibal in his right mind would ever eat a steak from a sick victim no matter how hungry he was. His meal must consist of a nice brave strong warrior. In this way he believes that he will acquire the attributes of this warrior. To eat a sick or aged man would doom him to all the ills and aches of the worn out individual.

The same reasoning should apply to engines. No part of an accident engine should ever be used to activate another engine until the cause of the accident has been determined and the part needed has been freed from any shadow of blame. The reasons for this are several.

1. It permits an examination of all parts and components of the engine in analyzing the cause of the accident.

2. It prevents a defective part which might have caused one accident from having the opportunity to cause a second one.—*JET SERVICE NEWS*

**ARCING BUS**—When an FJ-3 pilot, who was climbing at 100% retarded to 85% at 17,000 feet the engine promptly flamed out. At 9000 feet the engine was relighted with a normal airstart. The throttle was left at idle and a precautionary flame-out approach and landing was made.

Intermittent arcing in the bus bar connection at the radio noise filter, which is located in the aft fuel boost pump power supply circuit, caused loss of power to the boost pump and subsequent loss of fuel pressure. The arcing at the bus bar connection, high speed terminal of the radio noise filter, Part No. TF-51263, was caused by a loose nut on the terminal which allowed movement of the bus bar. The nut was loose because of a missing star lock washer. Since the subject nut is not normally removed during maintenance work or checks it is assumed that the lock washer was never on the terminal.

**SALVAGE PARTY**—An AD-6 was salvaged following a crash landing. The aircraft positioned on lowboy trailer by crane without incident. The AD was facing aft with chain over fuselage forward of empennage and small chains over wing roots serving as securing lines.

During movement to home base the driver of the lowboy, attempting to avoid an overhead traffic light, allowed the starboard stub wing to strike a

traffic light support pole resulting in impact damage to wing stub and flap. The impact force threw the plane against the chains over the fuselage which cut the fuselage almost in half.

Now the aircraft is a strike. Continued next page

FROM THE

# GROUND UP

Continued

**ODORS IN LIQUID OXYGEN** — When odors are detected in liquid oxygen systems, or in storage tanks or transfer trailers, the affected system should be purged with hot, dry, water-pumped nitrogen at approximately 150 degrees F.

Oil pumped nitrogen cannot be used as it will result in contaminating the Lq. Ox. system with hydrocarbons. Water lubricated gaseous pumps are on the supply table.

Nitrogen is a by-product of making Lq. Ox. and may be procured from Lq. Ox. suppliers. Odorless and harmless, it is a normal part of the air we breathe, it does not react readily with other materials, and is nonflammable and safe. It is used hot because it offers the best assurance of completely vaporizing any hydrocarbons.

It is to be heated by running it through a warm-up coil which is immersed in boiling water.

To purge transfer trailers or storage tanks, drain all Lq. Ox., open vent valves, connect gaseous source of hot nitrogen to fill drain connection of tank. Pass the gas through the tank at a moderate rate of flow for at least two hours. Stop the nitrogen flow, close the vent, and fill drain valves. Fill with Lq. Ox. and test for odor.

To purge the aircraft system, drain Lq. Ox. completely from converter system and allow system to warm up. Vent the system through the buildup vent valve. Connect nitrogen to the aircraft system using the filler nozzle, either as a direct connection or to the tank end ⅜-inch ID transfer hose. Pass hot nitrogen through the system for at least two hours. Then disconnect the nitrogen source and fill the system immediately with Lq. Ox. Test for odor. *For more details see ACSEB 7-57.—Ed*

**HELMET WANTED**—The port engine of an F7U-3 was being turned up in preparation for a night flight. A crewman assisting the start was standing too close to the intake. His hat, a baseball type, was drawn into the intake, resulting in damaged engine.

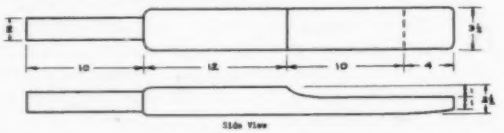
It was recommended that some type of protective helmet be made available for carrier squadrons while shore based as well as on board ship since it is necessary to wear some kind of head covering in cold weather.

*Helmets are now available from supply on a basis of 3 per assigned jet aircraft (Ref., page 7, Section H allowance list.) Legend is "Helmet, flight deck, sound attenuating . . . Type 3729H." Helmets available in standard crew colors: stock number R37H725—plus color code no.—Ed.*

**J-48 COMBUSTION CHAMBER REMOVER**—Maintenance men of VA-192 report that the use of a special wooden tool they have designed is most effective for removing combustion chambers from J-48 engines.

By placing the beveled end (see drawing below) of the tool under the combustion chamber and prying upwards a chamber can be removed in a matter of seconds, thus, eliminating the usual hammering with rawhide mallets or other tools which tend to damage chambers.

A 36-inch piece of hardwood stock with a cross-section slightly larger than a two-by-four is all the material needed for this tool.




**LOOSE COLLAR**—An S2F was on a local test flight after a port engine change. After a 90-minute flight the pilot returned to the field for landing. Upon lowering the landing gear the pilot smelled gasoline fumes and noted gasoline leaking from the port engine nacelle. The pilot notified the tower of the situation and requested fire equipment to stand by the runway in the event of fire. During the end of the landing rollout the gasoline ignited. When the plane came to a halt, the waiting fire trucks quickly extinguished the fire. Damage was limited to fuel lines, hydraulic lines and electrical cables in the accessory section of the port engine.

The collar of the main fuel line fitting to the carburetor apparently loosened during the flight allowing fuel to leak into the engine accessory section. A very reliable and competent crew had installed the new engine, and had thoroughly performed all ground checks required on a new engine installation including a pressure check. It is evident however, that the fuel connector must not have been fully tight in order for it to loosen.

**GUNNERY SAFETY MEASURES** — Failure to positively ensure that the gunnery system contains no ammunition prior to checking the gunnery electrical system and failure to clear the guns of all bore-sighting tools before firing has resulted in both bodily injuries and costly aircraft damage. In one case, an ordnanceman was checking the guns with the gun circuit tester probe. He inserted the probe down into the gun barrel and, after making contact with what he thought was the firing pin, he signaled the man in the cockpit to press the trigger. The gun fired, costing the ordnance man the loss of both hands. What he had thought was the firing pin was actually the end of a live shell. The applicable handbook procedure clearly emphasized the importance of checking the gunnery system to ensure that no ammunition is in the system. This unfortunate incident should serve as a warning to personnel that strict compliance with authorized procedures is a "must," especially where your life and the lives of others are concerned.

Another incident of a less serious nature occurred during a bore-sighting operation on an FJ-3. After aligning the right-hand gun, personnel signaled the pilot in the cockpit to fire the single round in the gun. The pilot fired the gun and the gun barrel ruptured causing major damage to the intake duct. Investigation disclosed that the accident was a direct result of failure to remove the boresighting tool from the muzzle of the gun prior to signaling the pilot to fire the gun. The reporting activity recommended that a procedure be used wherein the bore-sighting tools are removed and held up in view of the man in the cockpit prior to firing the guns.—*NAA Service News*

**MAINTENANCE INFO IN 'WEEKLY SUMMARY'** —Reports indicate many maintenance men seldom see a copy of the Weekly Summary of Aircraft Accidents. Since pertinent maintenance items appearing on its pages are, by all means intended to reach the men who need to know, copies should be made available to them.

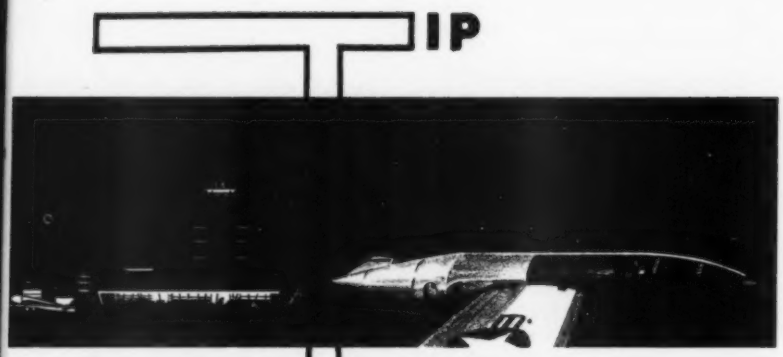
If it's the lack of sufficient copies to go around then drop a line to NASC letting your needs be known and extra copies will be sent you immediately.

**AMMO CAN HANDLES**—A pilot of an FJ-2 reported that engine surging and vibration occurred at approximately 92% rpm. Ground inspection revealed that the engine intake duct was bulged slightly inboard on both sides near the left- and right-hand forward ammunition cans. Both ammo cans were removed and the bulges disappeared. The inboard handle on each can was rotated to the inboard position (flush against the can) and the intake duct and the engine operated normally.

It should be noted that any time the ammo cans are installed, the handles must be rotated inboard; otherwise, the handles will cause a bulge in the intake duct. A decal to this effect is located on the top of the ammo cans.—*NAA Service News*

**LOST VIA FLIGA**—*Forced Landings, Incidents and Ground Accidents occurring during the first half of calendar 1957 have resulted in seven fatalities and a dollar loss of $6,646,576!*

Experience is still our best teacher: And in view of what it costs us, it oughta be ! ! !




**Miscellaneous**

**aviation safety information**

**DEADLINE**

AIRCRAFT escape system cartridges must be classified as over-age if the service (installed) limit is exceeded, or if shelf life plus installed time exceeds total life, as noted in the table.

| | Service Life | Total Life (Shelf Service) |
|---|---|---|
| Personnel Eject. Cat. Cartridge | | |
| Mk 1 Mod 0 | 2 yrs | 5 yrs |
| Mk 2 Mod 0 | 2 | 5 |
| Mk 3 Mod 0 | 2 | 5 |
| Delay Cartridge, ¾ Sec Lap Belt | | |
| Mk 1 Mod 0 | 1 | 3 |
| Delay Cartridge, TD-1C | | |
| | 2 | 6 |

For instance an ejection catapult cartridge which has been in storage 4 years *has only one year of service life.* Due to limited stocks, the maximum use, *within age limits,* is necessary. *Ref: BuAer Disp. 041545 April 1957*

**WINTER WEATHER INCIDENT**

DEPARTURE of flight delayed because of ATC hold. The weather 34°F and light to moderate snow, ceiling variable from 800 to 400 feet visibility sliding from ½ to one mile. Upon boarding the aircraft (DC-7) made a preliminary ice and snow accumulation observation and was satisfied that the leading edge was clear but some snow had accumulated on top of wing but was melting and flowing slowly, leaving me confident that it would flow off as we taxied and took off.

Considerable delay was encountered at the terminal, engines were started 40 minutes after the crew had boarded. Taxied out for runway 13L; held short time before crossing 13R; completed runup and received airway clearance. At this time we again made a visual check from the cockpit and noticed several ridges of snow that had apparently been caused by dragging the gas hose over the wing. These ridges were estimated an inch to perhaps two inches high. As we were making this observation the tower advised us to make immediate takeoff and expedite as an inbound flight was a mile and a half out on final.

Takeoff gross weight was something over 112,000 lbs. wind WNW and starting to become strong. The takeoff was normal but the wind somewhat gusty and was nearly directly cross so power was reduced and flaps retracted somewhat later than normal. At about (estimated) 150 ft. above field level flaps completed retraction and severe buffeting started. Immediately ordered full power, turned on wing and prop deicers and leveled out to gain speed—at 160 knots indicated buffeting had lessened to moderate but still severe enough to cause a settling and loss of altitude.

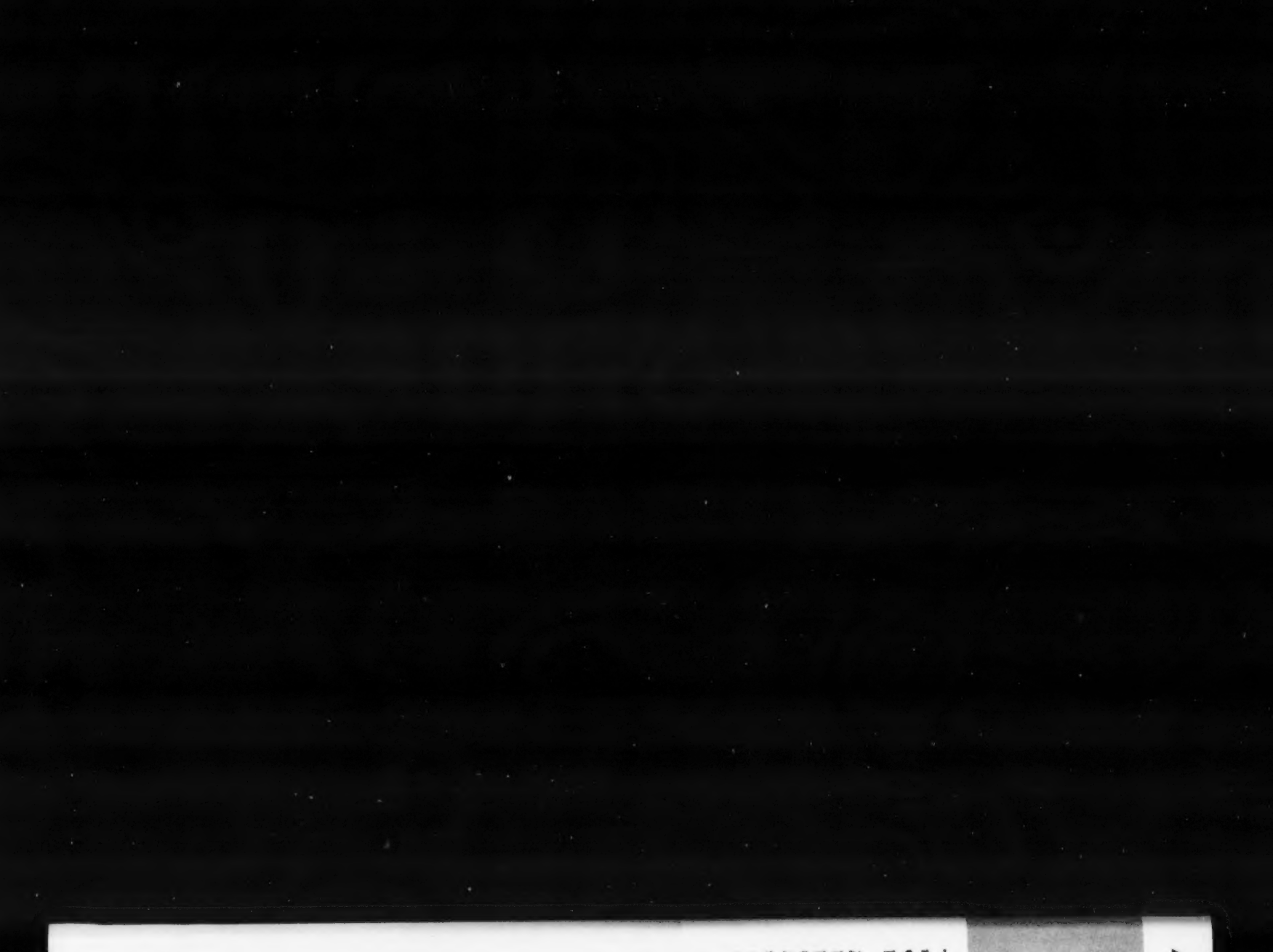
At this time and at about 170 knots indicated, we cracked the flaps and buffeting immediately stopped, normal climb performance was reinstated and we proceeded to about 2500 ft. MSL at that configuration but with intermediate power, then nosed down to level flight, retracted the flaps and at 190 knots indicated all buffeting stopped and normal performance was experienced. Still observed ridges of snow but they dissipated by sublimation during remainder of climb.

The temperature had dropped during the delay from 34°F to 29°F.—*An Air Line Pilot in ALPA's Technical Talk for Pilots.*

### *Flight Plan*

AFTER Adm. Richard E. Byrd flew over the North Pole, he said that he'd had no adventures. "But I could have, if I'd wanted to," he added. "I could have had plenty of adventures, if I hadn't made proper preparations for the trip. But I *did* make proper preparations—and so all I did was merely fly over and back, without adventures."

—Leonard Lyons in "Reader's Digest"



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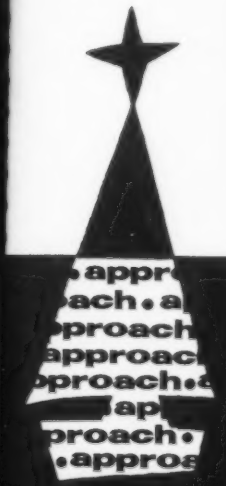



Place
Stamp
Here

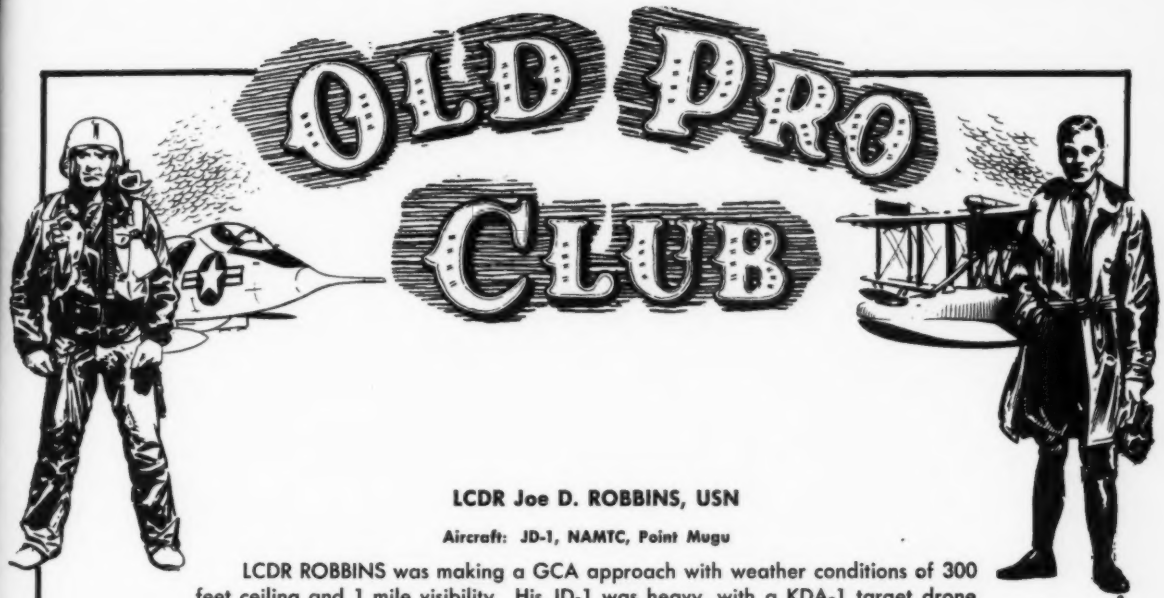
To _____

_____

_____

# MERRY CHRISTMAS from

_____




### LCDR Joe D. ROBBINS, USN

**Aircraft: JD-1, NAMTC, Point Mugu**

LCDR ROBBINS was making a GCA approach with weather conditions of 300 feet ceiling and 1 mile visibility. His JD-1 was heavy, with a KDA-1 target drone hung from the starboard wing and a compensating tank of water on the port wing. As he lowered full flaps during the approach, the plane commenced a roll to the right. This could have been reason for dropping the test target and water tank, but by a quick and accurate appraisal of the situation, LCDR ROBBINS determined the roll to be caused by a flap failure and immediately raised the flaps. A material failure in the flap hinge had caused the main section of the starboard flap to blow up and the smaller section separated from the wing. LCDR ROBBINS recovered on instruments, continued a fast approach and landed the plane.

### 1st LT Ronald B. LUTHER, USMC

**Aircraft: AD-6, VMA 251**

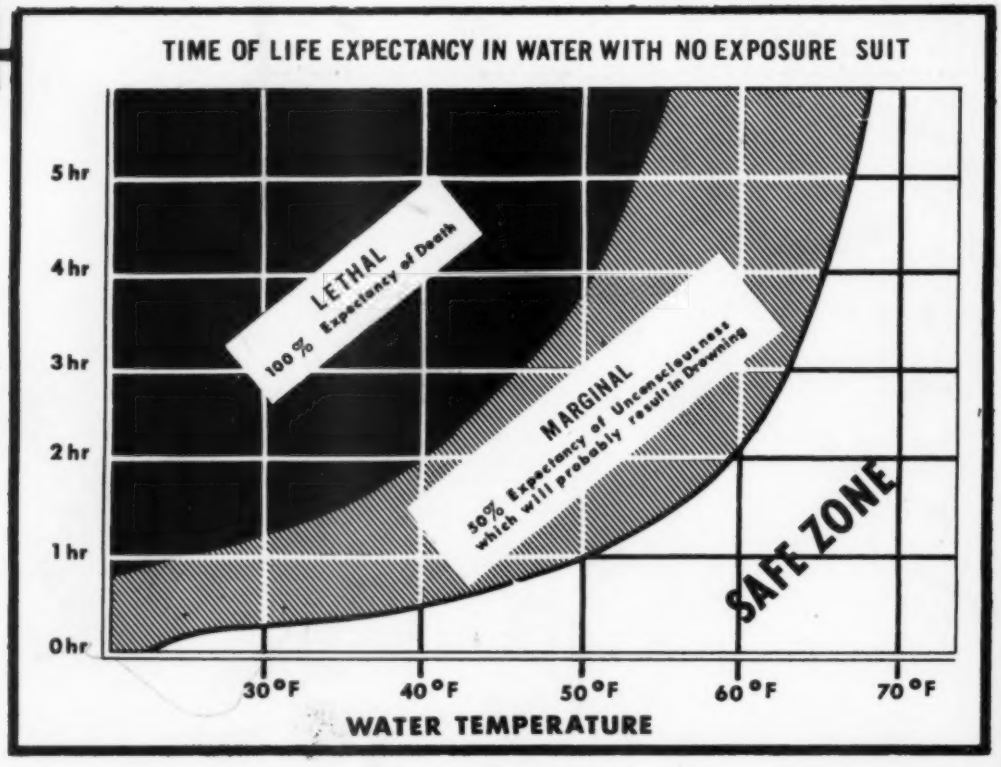
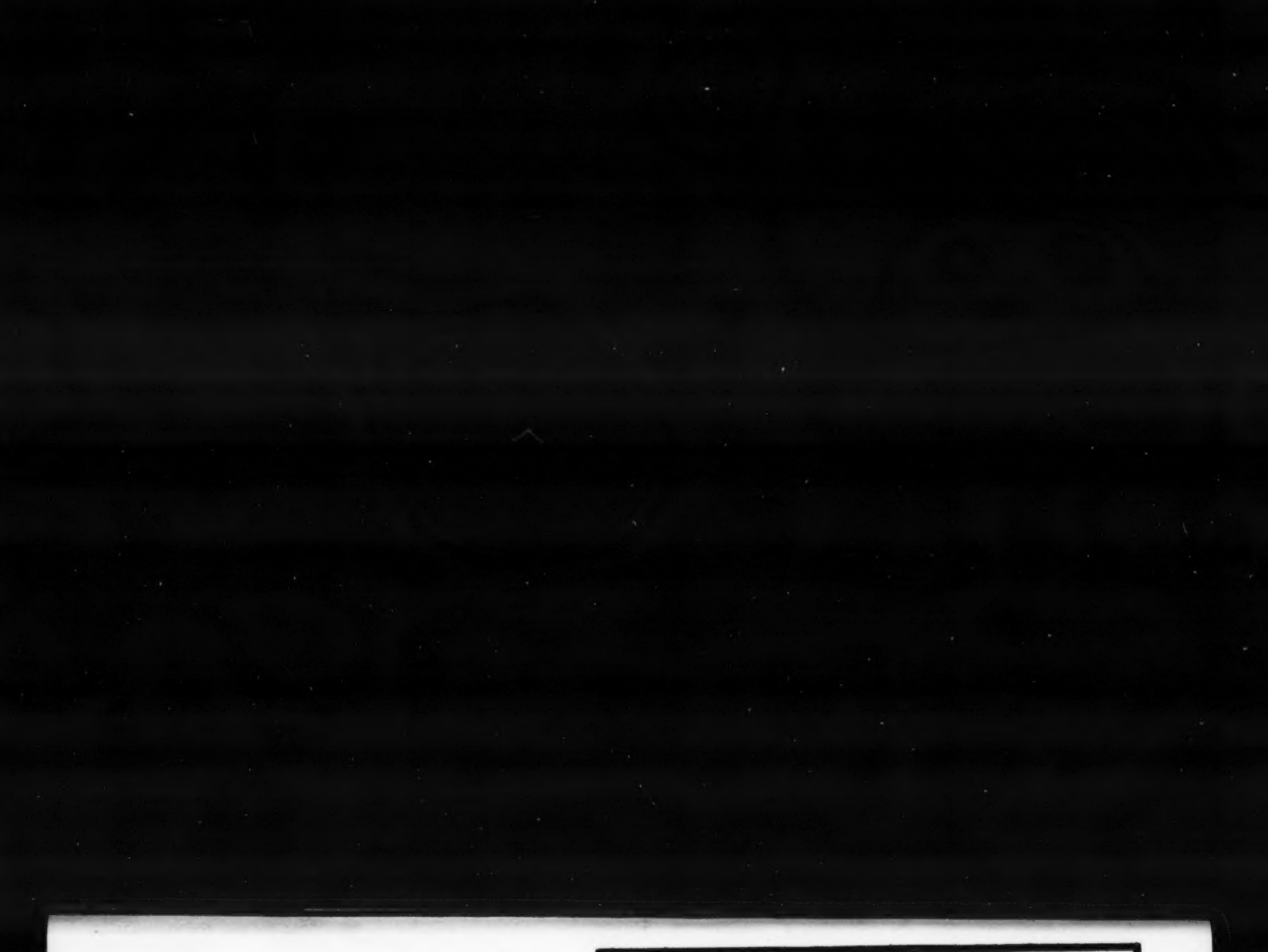
At 4000 feet, the engine quit without warning due to malfunction of the MAP regulator and fuel selector valve. LT LUTHER first checked the fuel selector switch, then transmitted his emergency report on guard, turned the fuel boost on, enriched the mixture, and pumped the throttle with negative results. At about 1000 feet, the mixture was placed in idle cut-off and the primer held down. The engine began to fire intermittently, and at about 100 feet above the water, began to run well enough to maintain altitude. Still on primer, a slow climb was made to about 300 feet and the mixture put in the rich position. But at 900 feet, the engine quit again and failed to restart on the primer until LT LUTHER had jettisoned the canopy and belly tank, prepared to ditch and was down to 10-15 feet altitude. Again on primer and then with rich mixture, he climbed to 1400 feet, where for the third time the engine quit. This time it started quickly on primer and then with the mixture in normal, a climb to 6000 feet was effected, the plane was flown to a small dirt air strip in the area and an uneventful emergency landing was made.

**Recognition of heads-up flying is essential to a positive program of flight safety. Each month, Approach will acknowledge certain selected individuals whose exhibited flying ability merits membership. Old Pro's also receive a wallet membership card as a memento of the occasion. Commanding officers are invited to submit nominations for selection.**

# POOPY SUIT *Blues*

Frankie and Johnny were launching
The flight deck was covered with snow
Frankie was wearing his poopy suit
But Johnny's was down below
He was a tiger, but he was doin' it wrong.

The cat fired them into the darkness
Into the cold foggy night
When *rooty-toot-toot*, left engine went "kaput"
But Johnny feathered the right
He was a tiger, but he feathered it wrong.

Bring on your HUPs and destroyers
Nellie Bly's dressed all in black
Frankie and Johnny went in the drink
But only Frankie's coming back
Johnny was a tiger, but he floated too long*

* **MORAL:** Even a warm-blooded tiger will freeze like an eskimo pie if dunked for too long without his dunking suit. Are you **SURE** you won't need yours on that next launch?